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DRAFT ENVIRONMENTAL IMPACT STATEMENT ON COLSTRIP ELECTRIC GENERATING UNITS 3 & 4, 500 KILOVOLT TRANSMISSION LINES & ASSOCIATED FACILITIES

VOLUME ONE SUMMARY

ENERGY PLANNING DIVISION, MONTANA STATE DEPARTMENT
OF NATURAL RESOURCES AND CONSERVATION

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DRAFT ENVIRONMENTAL IMPACT STATEMENT ON

THE PROPOSED MONTANA POWER COMPANY, PUGET SOUND POWER & LIGHT COMPANY, PORTLAND GENERAL ELECTRIC COMPANY, PACIFIC POWER AND LIGHT COMPANY, AND WASHINGTON WATER POWER COMPANY, COLSTRIP ELECTRIC GENERATING UNITS 3 & 4, 500 KILOVOLT KV TRANSMISSION LINES FROM COLSTRIP TO HOT SPRINGS, MONTANA, AND ASSOCIATED FACILITIES

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ENERGY PLANNING DIVISION
ALBERT C. TSAO, ADMINISTRATOR
DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
GARY J. WICKS, DIRECTOR

NOVEMBER, 1974

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CHAPTER ONE Introduction and Methodology

The Utility Siting Act was passed in March 1973 to regulate the construction and operation of certain utility facilities in Montana. The Montana Department of Natural Resources and Conservation (Department or DNRC) was assigned the responsibility of administering this Act, and, by order of the Department Director, the Energy Planning Division of the Department was created to assume this responsibility.

1.1. The Application

In accordance with the Siting Act, an application was filed with the Department on June 6, 1973, for permission to construct two 700 megawatt (MW) electrical generating units (Units 3 and 4) to be located at Colstrip, Montana; the associated facilities of the units; and two 500 kilovolt (KV) transmission lines with accompanying terminal equipment extending from Colstrip to Hot Springs, Montana. All of these will hereafter be referred to as the Colstrip Project.

The five utility companies which applied jointly for the Colstrip Project are Montana Power Company, 30% ownership; Puget Sound Power and Light Company, 25% ownership; Portland General Electric Company, 20% ownership; The Washington Water Power Company, 15% ownership; and Pacific Power and Light Company, 10% ownership.

The proposed location of Units 3 and 4 is east of Colstrip in Section 34, T2N, R41E, Rosebud County (see locator map included in this section). According to the application, the units would each contain a steam generator capable of producing approximately 5,000,000 pounds of steam per hour. Each unit would also have a 700 MW turbine generator, an evaporative, cross-flow induced draft cooling tower, a stack at least 500 feet in height, and alkali scrubbers for air pollution control. The units would each require approximately 885,000 to 903,000 pounds of coal per hour depending on the coal's BTU content. It is proposed that this coal be obtained by strip mining from a nearby area at the rate of approximately 130 surface acres per year. The accompanying photographs show an aerial view of Colstrip and the power plant site where Units 1 and 2 are presently under construction.

The units' associated facilities include a 36" pipeline which would draw 26,000 acre feet (maximum consumption) of water per year, or about 37 cubic feet per second (cfs), from the Yellowstone River. This line would extend approximately 30 miles from the river at Nichols to the plant site. Sixty surface acres of land in the general area of the power plant would be required for settling ponds for the water.

The proposed electric transmission system consists of two 500 KV lines. One line would be constructed over the entire distance from Colstrip to Hot Springs, approximately 430 miles. The other 500 KV line would be created by converting a proposed double-circuit 230 KV line (not yet constructed) from Colstrip to Billings to 500 KV capacity, and constructing a second new 500 KV line, connected to the newly converted line at Billings, from Billings to Hot Springs. The applicants have submitted one preferred and

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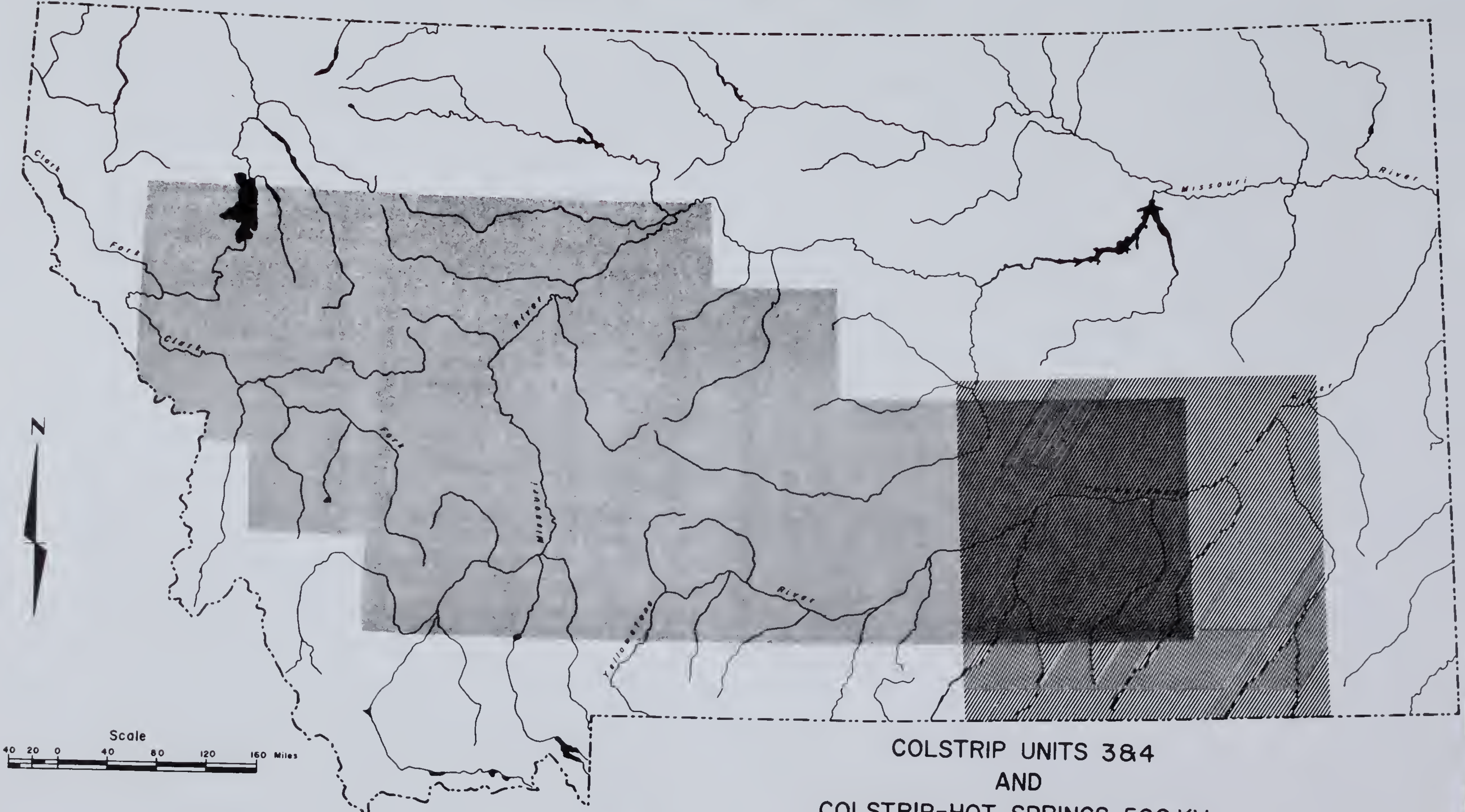


COLSTRIP UNITS 3&4
AND
COLSTRIP-HOT SPRINGS 500 KV
TRANSMISSION LINES STUDY

■ TRANSMISSION LINES STUDY AREA

▨ POWER PLANT STUDY AREA

Aerial View of
Colstrip

Power Plant Site

several alternative corridors which these lines could follow. A substation for transforming, switching, and relaying the power carried by the lines has been proposed in the Broadview area, and a substation for switching and relaying of power is proposed for the Helena area.

Detailed analyses of all aspects of the power plant and transmission line components contained in other Volumes of this draft environmental impact statement (EIS) are available from the Department. All studies presented herein should be considered preliminary. Further analyses will be published in the final EIS.

1.1.1. Objectives and Potential Results of This Study

This EIS is the product of a study conducted by the Energy Planning Division to evaluate the proposed facilities and their probable effects on the surrounding natural and cultural environment.

A primary objective of this study is to provide the basis for the Department's recommendations concerning the project to the Board of Natural Resources and Conservation. The Board has the authority to make the final decision on the project, based on certain criteria outlined in the Utility Siting Act. The application may be approved or denied as filed, or the project may be approved upon such terms, conditions, or modifications of the construction, operation or maintenance of the facility as the Board may deem appropriate. It is, therefore, one objective of this study to provide a thorough analysis and examination of all criteria required for the decision-making process. These criteria are explained in the study methodology discussion presented in Section 1.2.

A second objective of this study is to document the manner and the magnitude of the probable impacts of the Colstrip Project in order to fulfill the requirements of the Montana Environmental Policy Act and the National Environmental Policy Act.

1.1.2. Action Taken by the Energy Planning Division

1.1.2.1. Methodology Development

As science and technology improve and population increases, human activities (such as power plant construction and suburban development) become more and more complicated and may conflict with each other. Activities which misuse land or lack adequate planning and control may, although occupying only a small land area, nevertheless trigger a series of interlocked reactions which affect other activities. Thus, it is becoming increasingly necessary to have planning and constraints.

Human activities are often contradictory in many aspects, and no single academic discipline or theory can be expected to explain all aspects of the realm of activities. Neither can any discipline or theory serve as a comprehensive guide to policy formation or land use planning procedures (i.e., one theory may solve the problems related to one academic field, but may leave the problems related to other fields untouched or in even worse condition). For instance, a well-designed industrial plant may achieve operational reliability and reduced installation costs, but may not solve (and may worsen) the problems related to local community economics and social issues.

Therefore, to date, substantial agreement has been reached concerning a "multidisciplinary approach" to any type of land use and resource planning. Above all, special emphasis has been placed upon establishing a methodological framework. Land use and resource planning is an extremely complex task, not only involving the natural environment, but also dealing with economic and social systems. Furthermore, it requires design skill, utilizing psychophysiological criteria as design and construction standards in order to build accommodations for socioeconomic activities within a given natural environment. All of these concerns must also interact in the context of time. The detailed study methodology of this project is explained in Volume 2, Chapter 3 and Volume 4, Chapter 1 of this study.

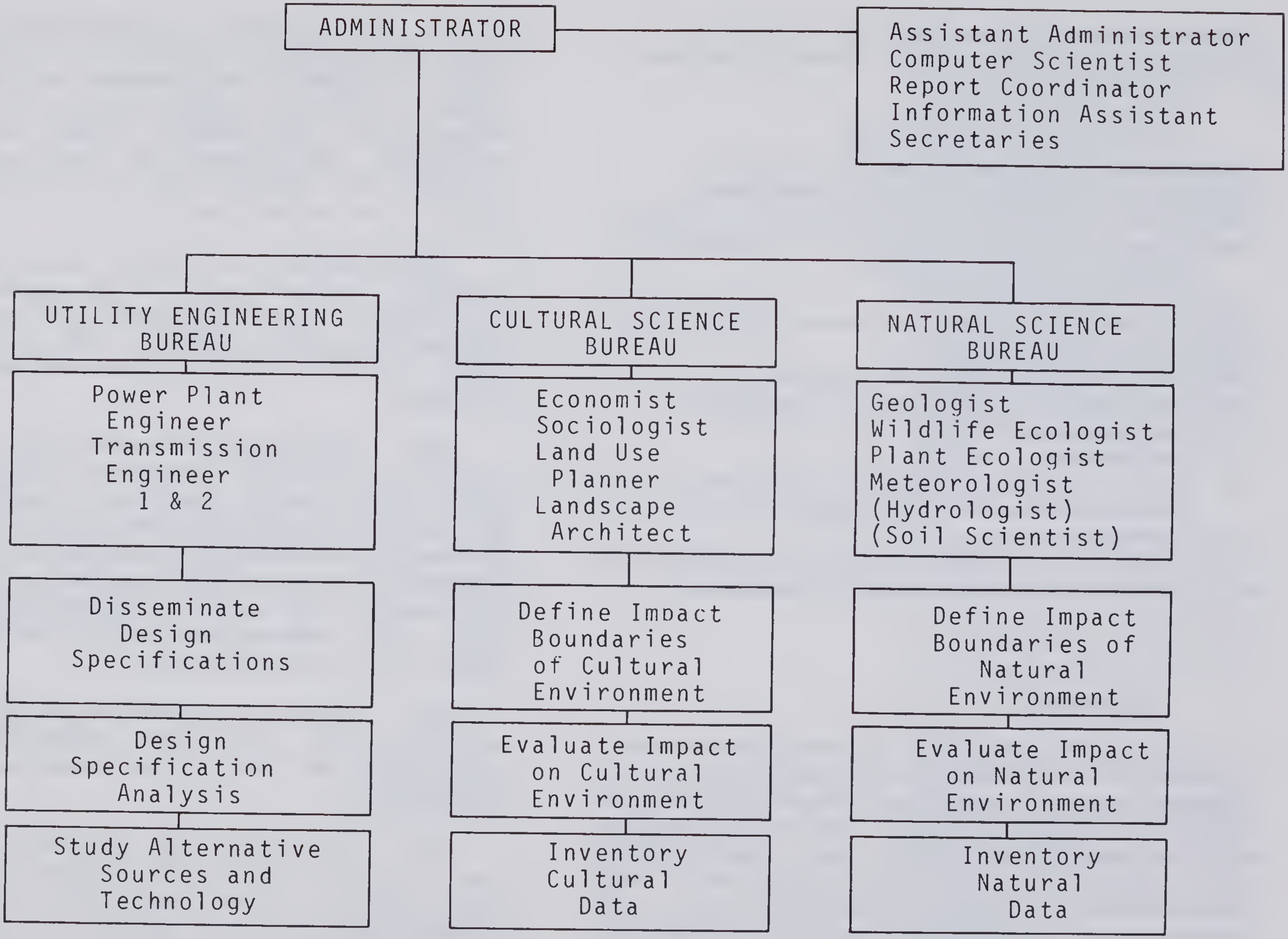
1.1.2.2. Internal Organization

In order to fulfill the responsibility of administering the Utility Siting Act, the Energy Planning Division has been organized as a multidisciplinary team and divided into three bureaus which handle the major areas of analyses needed to process a utility application. The Utility Engineering Bureau examines the design and operational characteristics of a proposed utility facility, and compares other potential sources of energy and other technologies with the ones that are proposed. The responsibilities of the Cultural Sciences Bureau include conducting inventory and impact analyses of social and economic factors and land uses which would be affected by the proposed facility. The Utility Engineering Bureau and the Cultural Sciences Bureau jointly investigate the basis of need for the proposed facility. The Natural Sciences Bureau conducts investigations of natural elements which would be affected, such as geology, hydrology, soils, vegetation, wildlife and meteorology. A detailed illustration of the Division's organizational structure is shown in the diagram on the following page.

For all types of proposed utility facilities, the information collectively gathered by the three bureaus is ultimately used to formulate the Department's recommendations on the project, which are presented to the Board. Close interaction among the Division staff is essential during the entire study period.

1.1.2.3. Contracts

Parts of this study fall within other state agencies' or consultants' areas of expertise. Therefore, contracts were made to utilize this expertise and assist the Energy Planning Division in fulfilling the requirements of the Utility Siting Act. The agencies and individuals contracted are listed as follows:


ADMINISTRATOR
Assistant Administrator
Computer Scientist
Report Coordinator
Information Assistant
Secretaries
UTILITY ENGINEERING BUREAU
Power Plant Engineer
Transmission Engineer 1 & 2
Disseminate Design Specifications
Design Specification Analysis
Study Alternative Sources and Technology
CULTURAL SCIENCE BUREAU
Economist
Sociologist
Land Use Planner
Landscape Architect
Define Impact Boundaries of Cultural Environment
Evaluate Impact on Cultural Environment
Inventory Cultural Data
NATURAL SCIENCE BUREAU
Geologist
Wildlife Ecologist
Plant Ecologist
Meteorologist
(Hydrologist)
(Soil Scientist)
Define Impact Boundaries of Natural Environment
Evaluate Impact on Natural Environment
Inventory Natural Data

Department of Fish and Game
Department of Health and Environmental Sciences
    Air Quality Bureau
    Water Quality Bureau
    Occupational Health Bureau
Department of Intergovernmental Relations
University of Montana -- Botany Department
Department of Social and Rehabilitation Services
Department of Natural Resources and Conservation
    Water Resources Division
Public Service Commission
Montana State University -- Economics Department
Harza Engineering Company
Battelle Pacific Northwest Laboratories
Dr. Stan Anderson, Professor of Electrical Engineering, Illinois Institute of Technology
Dr. Frank McCandless, Associate Professor of Mechanical Engineering, Montana State University
Dr. Ralph E. Powe, former Professor of Mechanical Engineering, Montana State University

1.2. Methodology

The evaluation of the Colstrip Units 3 and 4 generation and transmission application uses a planning process for decision-making. The elements of study are shown in the accompanying diagram entitled "Colstrip Units 3 and 4 Study-Flow Diagram." The systematic execution of this process helps provide documentation that all requirements in the Utility Siting Act have been satisfied prior to submission of the departmental recommendations to the Board of Natural Resources and Conservation. The methodology also provides a measure of organizing and simultaneously directing a complex series of separate but interrelated social, economic, environmental and engineering studies. Although specific inventory and analysis methods have been employed in each component of the study, the purpose of this section is to describe the general steps taken throughout the course of the entire study.

Opportunities for public participation are available at each step in the process. Public involvement has been formalized with meetings and hearings at later stages, such as during the review period of the draft environmental impact statement.

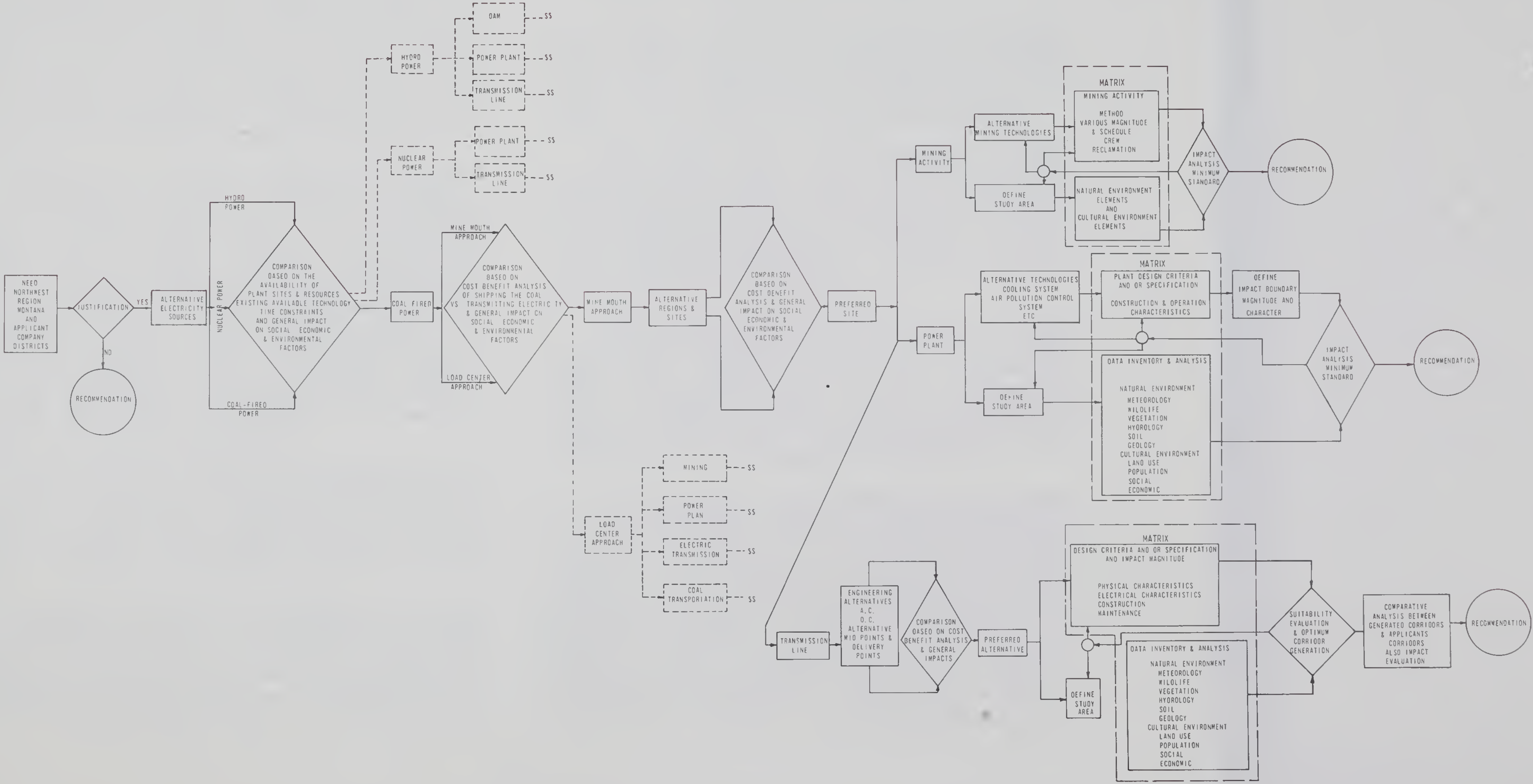
The Departmental recommendations, to be included in the final environmental impact statement, will be largely based on an analysis of all the elements contained in the Utility Siting Act. Because of this the major steps in the study have progressed concurrently rather than sequentially. For example, the inventory of natural and social values was conducted even though the basic question of need was unanswered.

For purposes of illustration the following narrative will follow the study-flow diagram recognizing that the various steps have occurred concurrently.

The first step in the process is an evaluation of need for the facility (Chapter 2). There are technical, social and legal sides to the determination of need. Technical considerations include an analysis of load growth in Montana, the Pacific Northwest and the service districts of the applicant utilities. This allows for a

COLSTRIP UNITS 3 & 4 STUDY-FLOW DIAGRAM

ENERGY PLANNING DIVISION DEPARTMENT OF NATURAL RESOURCES & CONSERVATION


NEED NORTHWEST REGION MONTANA AND APPLICANT COMPANY DISTRICTS
JUSTIFICATION
YES
NO
RECOMMENDATION
ALTERNATIVE ELECTRICITY SOURCES
HYDRO POWER
NUCLEAR POWER
COAL-FIRED POWER
COMPARISON BASED ON THE AVAILABILITY OF PLANT SITES & RESOURCES EXISTING AVAILABLE TECHNOLOGY TIME CONSTRAINTS AND GENERAL IMPACT ON SOCIAL ECONOMIC & ENVIRONMENTAL FACTORS
HYDRO POWER
DAM
$$
POWER PLANT
$$
TRANSMISSION LINE
$$
NUCLEAR POWER
POWER PLANT
$$
TRANSMISSION LINE
$$
COAL FIRED POWER
MINE MOUTH APPROACH
LOAD CENTER APPROACH
COMPARISON BASED ON COST BENEFIT ANALYSIS OF SHIPPING THE COAL VS TRANSMITTING ELECTRICITY & GENERAL IMPACT ON SOCIAL ECONOMIC & ENVIRONMENTAL FACTORS
MINE MOUTH APPROACH
LOAD CENTER APPROACH
MINING
$$
POWER PLAN
$$
ELECTRIC TRANSMISSION
$$
COAL TRANSPORTATION
$$
ALTERNATIVE REGIONS & SITES
COMPARISON BASED ON COST BENEFIT ANALYSIS & GENERAL IMPACT ON SOCIAL ECONOMIC & ENVIRONMENTAL FACTORS
PREFERRED SITE
MINING ACTIVITY
ALTERNATIVE MINING TECHNOLOGIES
DEFINE STUDY AREA
MATRIX
MINING ACTIVITY
METHOD VARIOUS MAGNITUDE & SCHEDULE CREW RECLAMATION
NATURAL ENVIRONMENT ELEMENTS AND CULTURAL ENVIRONMENT ELEMENTS
IMPACT ANALYSIS MINIMUM STANDARD
RECOMMENDATION
POWER PLANT
ALTERNATIVE TECHNOLOGIES COOLING SYSTEM AIR POLLUTION CONTROL SYSTEM ETC
DEFINE STUDY AREA
MATRIX
PLANT DESIGN CRITERIA AND OR SPECIFICATION
CONSTRUCTION & OPERATION CHARACTERISTICS
DATA INVENTORY & ANALYSIS
NATURAL ENVIRONMENT
METEOROLOGY
WILDLIFE
VEGETATION
HYDROLOGY
SOIL
GEOLOGY
CULTURAL ENVIRONMENT
LAND USE
POPULATION
SOCIAL
ECONOMIC
DEFINE IMPACT BOUNDARY MAGNITUDE AND CHARACTER
IMPACT ANALYSIS MINIMUM STANDARD
RECOMMENDATION
TRANSMISSION LINE
ENGINEERING ALTERNATIVES A.C. D.C. ALTERNATIVE MID POINTS & DELIVERY POINTS
COMPARISON BASED ON COST BENEFIT ANALYSIS & GENERAL IMPACTS
PREFERRED ALTERNATIVE
DEFINE STUDY AREA
MATRIX
DESIGN CRITERIA AND OR SPECIFICATION AND IMPACT MAGNITUDE
PHYSICAL CHARACTERISTICS
ELECTRICAL CHARACTERISTICS
CONSTRUCTION
MAINTENANCE
DATA INVENTORY & ANALYSIS
NATURAL ENVIRONMENT
METEOROLOGY
WILDLIFE
VEGETATION
HYDROLOGY
SOIL
GEOLOGY
CULTURAL ENVIRONMENT
LAND USE
POPULATION
SOCIAL
ECONOMIC
SUITABILITY EVALUATION & OPTIMUM CORRIDOR GENERATION
COMPARATIVE ANALYSIS BETWEEN GENERATED CORRIDORS & APPLICANTS CORRIDORS ALSO IMPACT EVALUATION
RECOMMENDATION

prediction of future energy consumption. The social aspects of need relate to energy conservation efforts and the effects of utility promotional activities on load growth. Also included is differentiation between need and demand and a consideration of changing lifestyles. The legal basis of need is derived, in part, from an interpretation of need under the Utility Siting Act. A request for this interpretation has been made to the Attorney General and may be available in the final environmental impact statement.

The second step in the process is to compare the applicants' proposed electricity sources - (i.e., coal-fired power plant) with alternative sources of electricity (Chapter 3). Potential sources such as solar, wind, and geothermal are reviewed. However, the most detailed comparison is made between the sources that are presently developable: hydro, nuclear and coal-fired. The comparison is based on the availability of plant sites and resources for each energy source, existing technology, time constraints of licensing and construction, and impact on the social, economic and natural environment.

Another issue concerns the distribution of future electric growth to the major power sources of hydro, nuclear and fossil fuel. This is a complex national and regional question which cannot be resolved at the state level.

If coal-fired power is determined to be the most acceptable source of electricity for this project, the next step is to analyze mine-mouth generation versus the load center approach. This comparison is largely based on cost-benefit analysis of shipping the coal to the load center versus transmitting electricity. Economic analysis is applied here in the broadest sense to include long-run costs as well as social and environmental effects (Chapter 4).

Further exploration of the mine-mouth approach leads to an evaluation of alternative plant sites. Again, the alternatives are appraised by means of a cost-benefit analysis of impact on the human and natural environment.

This study will eventually point toward a preferred plant site (i.e., Colstrip site). The evaluation of impact on the preferred site and location-related measures to minimize the impact is in process. Three major components constitute this investigation: mining activity, the power plants, and the transmission lines.

The mining activity study considers alternative mining technologies and a definition of the impact area (Chapter 7). Natural and cultural values are inventoried as a basis for determining impact. Possible effects of plant emissions on vegetation and hence on the feasibility of reclamation, are also studied (Chapter 8).

The power plant study began with an analysis of the applicants' plant design objectives or criteria as well as the construction and operational characteristics of the proposed facilities (Chapter 6). A thorough understanding of these criteria and characteristics enables one to more accurately define the impact boundary and its magnitude, and to determine the type and extensiveness of environmental elements that should be inventoried. As a result, a common study area was selected to include all data sampled for impact analysis surrounding the applicants' preferred site.

Constructional and operational characteristics of the power plant vary with the technological method used. One method may fulfill the required engineering performance, but may not be acceptable from the standpoint of environmental impact or vice versa. Therefore, the study of alternative technologies such as cooling and air emission control systems (Chapter 5) is based on premises which are acceptable from various standpoints. A check-back "loop" is used to ensure that these premises have been adequately examined. Also, various check-back "loops" have been used throughout the entire methodology for similar purposes.

A matrix is constructed with a list of the natural and cultural elements on the horizontal (x) axis and construction, operation, maintenance and mining characteristics of the power plants on the vertical (y) axis (see the accompanying matrix). This matrix is used to identify the affected environmental elements and the degree of impact.

After the power plant characteristics have been analyzed and related environmental elements have been inventoried, the evaluation of the impact shall include a literature search of existing related impact studies and a discussion of impacts which may specifically occur within the study area. A check is made to judge whether all potential impacts will meet minimum environmental protection standards (Chapter 8).

The third major component of this study concerns the transmission system. A typical EIS process (which primarily includes analysis of impacts) rather than a planning procedure (which is used for decision-making) has been employed to evaluate the corridor impact of the proposed Colstrip to Hot Springs 500 KV lines. (A detailed discussion of this methodology is presented in Volume 4, Chapter 1 of this impact statement.) However, a planning procedure has been used for the analysis of need and alternatives for the lines to insure that these strategy related decisions (corridor selection considered a tactical related decision) of the applicants are thoroughly examined. For corridor selection, emphasis has been placed on the construction and design criteria of the proposed lines, and the theoretical impact of the lines. The planning process will be used later to select an optimum corridor. Comparisons will be made between this optimum corridor and the applicants' preferred corridor. All of this material will be published in the final environmental impact statement on this project.

The fact that all of the steps have been taken in the Colstrip 3 and 4 study which lead toward consideration of the applicants' complete proposal should not be interpreted as an endorsement of that proposal. On the contrary, the basic decision of approval or disapproval has not yet been made.

The "recommendations" indicated in the - study-flow diagram will not be made until the final EIS is released in January, 1975.

POWER PLANT STUDY MATRIX

OPERATION																COAL ACTIVITIES						PHYSICAL CHARACTERISTICS				CONSTRUCTION			PLANT CHARACTERISTICS			
TAX	LABOR FORCE	MATERIAL FLOW OUT (BOTH QUALITY & QUANTITY)										MATERIAL FLOW IN (BOTH QUALITY & QUANTITY)				TAX	LABOR FORCE	COAL STORAGE	COAL TRANSPORTATION	RECLAMATION	STRIP MINING	PHYSICAL FORM - POWER PLANT COMPLEX	FOUNDATION REQUIREMENT			LABOR FORCE	CONSTRUCTION NOISE	CONSTRUCTION DUST				
		ELECTRICITY	NOISE	RADIATION	SOLID WASTES	LIQUID WASTES	EXHAUSTED GAS					CHEMICAL MATERIALS	WATER	AIR	COAL								WATER STORAGE POND	ASH POND	POWER PLANT							
							ETC	TRACE ELEMENTS	PARTICULATES	NO_x	SO_2																		ENVIRONMENTAL ELEMENTS			
																													GEOLOGY			NATURAL ELEMENTS
																													SOIL			
																													GROUND WATER	HYDROLOGY		
																													SURFACE WATER			
																													TERRESTRIAL	VEGETATION		
																													AQUATIC			
																													TERRESTRIAL	WILDLIFE		
																													AQUATIC			
																													AIR	METEOROLOGY		
																													MICROCLIMATE			
																													HUMAN (PHYSICAL HEALTH)		LOCAL AREA	CULTURAL ELEMENTS
																													CROP			
																													LIVESTOCK			
																													EXISTING	LAND USE PATTERN		
																													PROJECTED			
																													POPULATION (SIZE)			
																													SOCIAL	COMMUNITY STRUCTURE		
																													ECONOMIC			
																													PUBLIC	COMMUNITY SERVICE		
																													SEMI-PUBLIC			
																													PRIVATE			
																													DISTANT AREA (POPULATION & COMMUNITY BENEFITTERS)			

CHAPTER TWO The Need for the Proposed Facility

The need for Colstrip Units 3 and 4 must be judged in terms of the need for their output. This need can be interpreted in many ways, and there is probably no criterion of need that is universally acceptable. Levels of consumption of electricity that one needs to "keep up with the neighbors" may be quite different from the level one needs to be comfortable, which in turn may be quite different from the national per capita level needed simply for survival of the human species. Because these levels of need form a continuum, it is difficult to select the point on that continuum that separates a "real" need from a "frivolous" need.

If it is difficult to define need in absolute terms, a relative approach may be more fruitful. Need can be evaluated in terms of alternatives. If there are viable alternative sources, the need for Colstrip Units 3 and 4 is certainly diminished. Likewise, if the costs, both dollar costs to the consumer and full costs to society, are prohibitive, the need for Colstrip Units 3 and 4 may prove to be weak.

In this chapter a conservative approach to the problem is taken; need itself is not defined. The consumption of electricity over the past decade, although it can not be equated with need, is listed, and future consumption is estimated, based on these figures. The difference between need and consumption is left to the reader to decide. It is hoped that the record and projections of consumption will at least provide the reader with a basis from which to start.

2.1. Historic Electric Consumption

For the nation as a whole, the record of electric consumption shows a doubling about every 10 years over the past four decades. This has led to an abnormal degree of confidence in continued growth at the doubling-in-10-years rate; underlying causes are given little attention, and growth is treated as if it were a function of time alone.

In projecting electric consumption in the Northwest, a number of underlying sources of growth should be included. The major determinants of electric consumption will be discussed, but they are not included in the projections. Included, however, is a decline in the rate of growth of electric consumption in the Northwest generally. The doubling-in-10-years growth rate does not apply in this region over the past several years.

Consumption data for 10 or 11 years are shown in Table 2-1. All figures are in terms of average ultimate customer usage over the years listed. The five applicant companies, Puget Sound Power and Light Company (PSP&LC), Portland General Electric Company (PGEC), Pacific Power and Light Company (PP&LC), Washington Water Power Company (WWPC), and Montana Power Company (MPC) are noted. The Northwest Power Pool (NWPP) data include sales in Utah, Nevada, California, and British Columbia, in addition to all of Oregon, Washington and Idaho and most of Montana (see the accompanying map). Ultimate sales in the area, defined by the state boundaries of Montana, Idaho, Washington, and Oregon (M+I+W+O), are also included (see accompanying map of applicants' service districts).

TABLE 2-1

AVERAGE ENERGY SALES TO ULTIMATE CUSTOMERS (MW)

YEAR	PSP&LC	PGEC	PP&LC	WWPC	MPC	NWPP[1]	MONTANA, IDAHO, WASHINGTON AND OREGON
1961							6091
1962							6410
1963	425	590	909	336	318	9196	6778
1964	460	642	978	352	352	10287	7303
1965	493	665	1037	363	379	11188	7840
1966	551	728	1121	383	416	12103	8501
1967	618	768	1144	391	372	12789	9104
1968	705	859	1218	453	400	14248	9736
1969	787	949	1318	452	455	15044	10789
1970	838	1002	1397	466	470	15543	10897
1971	907	1194	1471	497	469	16188	11339
1972	1013	1186	1560	526	493	17311	11883
1973	1052	1225	1635	542	485		

[1] NWPP figures are on a July 1 to June 30 operating year. The figure shown is the average system load figure for July 1 of year shown to June 30 of the following year.

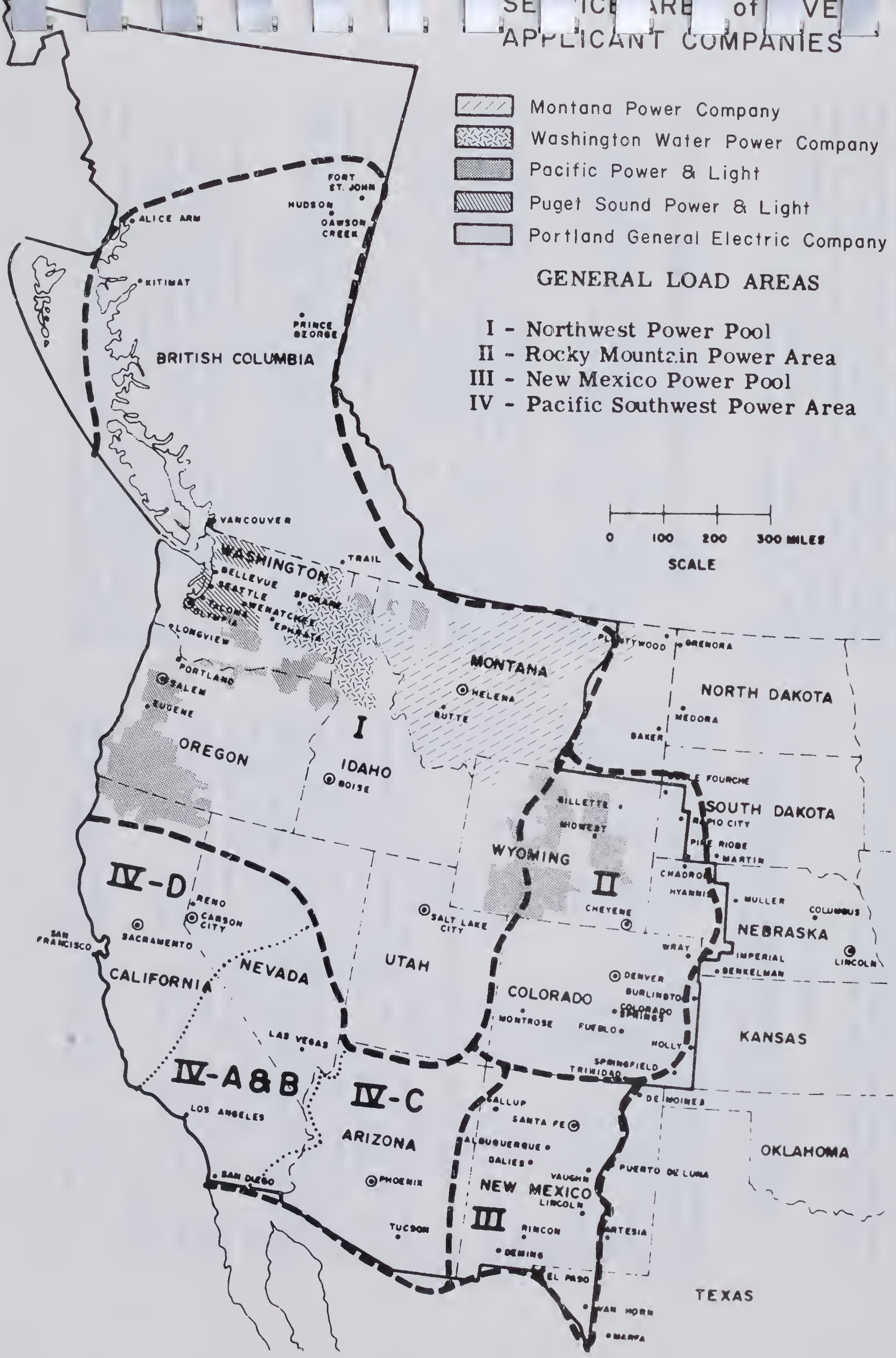
Sources: PSP&LC, PG&EC, PP&LC and WWPC figures furnished by Companies; MPC figures from Form 1., Report to F.P.C.

NWPP figures are courtesy of the Northwest Power Pool Coordinating Group.

Montana, Idaho, Washington and Oregon data are from Historical Statistics of the Electric Utility Industry Through 1970, Edison Electric Institute, and the Statistical Year Book of the Electric Utility Industry for 1972, Edison Electric Institute.

All figures are converted to average use from total annual use.

SE ICE ARE of VE
APPLICANT COMPANIES



▨ Montana Power Company
▨ Washington Water Power Company
▨ Pacific Power & Light
▨ Puget Sound Power & Light
☐ Portland General Electric Company

GENERAL LOAD AREAS

I - Northwest Power Pool
II - Rocky Mountain Power Area
III - New Mexico Power Pool
IV - Pacific Southwest Power Area

In Table 2-2 below, the data from Table 2-1 have been used to calculate average annual growth rates for each company and group.

Table 2-2

COMPARISON OF AVERAGE ANNUAL GROWTH RATES, SINCE 1963 AND SINCE 1968

Company or Group	% Annual Growth Since 1963	% Annual Growth Since 1968
PSP&LC	9.5	8.3
PGEC	7.6	7.4
PP&LC	6.0	6.1
WWPC	4.9	3.7
MPC	4.3	3.9
NWPP	7.3	5.0
M+I+W+O	6.3*	5.1

*Represents % annual growth 1961-1972

Growth of sales seems to have slowed down over the past five years. The differences are substantial, and, if in fact they do represent a trend, the implications for future load growth are significant. For instance, with regard to NWPP figures, the difference between two 10 year projections (one based on a 7.3% annual growth rate and the other based on a 5% annual growth rate), applied to 1972-1973 average use data for NWPP, is 6,822 MW. This difference is more than four times the expected average output of the proposed Colstrip project (Units 1 through 4 combined).

Table 2-3 gives peak demand data for the five applicant companies and the NWPP. Peak demand is the maximum customer demand on the system considered over the entire observed time period (one year). It represents a measure of the maximum level of resources the system must have available to supply customers. All figures in Table 2-3 except those for MPC are based on a July 1 to December 31 calendar year.

2.2. Projected Peak and Average Loads

Tables 2-1 and 2-3 are the bases upon which projections of future average and peak loads are made. These projections appear in Table 2-4 and Table 2-5, respectively.

The projections of average energy sales made in Table 2-4 are based on sales data since 1968. Instead of using average annual growth rates (as displayed in Table 2-2), regression analysis was used to fit an exponential curve to the data points. This has the advantage of using the information embodied in the data between the end points as well as the information in the end points themselves. Use of average annual growth rates puts all the emphasis on the first and last points in the data series; the information from intermediate years is lost.

The exponential equation selected to project load growth was based on a criterion of how well that equation fit the data. The criterion used is that the "best" fitting exponential equation is that equation which minimizes the sum of the squared differences between the observed data points (sales in each of the years) and the curve that the equation represents. The "least squares"

TABLE 2-3

PEAK SYSTEM DEMAND (MW)

OPERATING YEAR	PSP&LC	PGEC	PP&LC	WWPC	NWPP	YEAR	MPC
1963-4	875	1139	1520	651	13442	1964	649
1964-5	1139	1507	1756	764	16465	1965	
1965-6	1074	1375	1771	679	16431	1966	736
1966-7	1140	1319	1748	700	17097	1967	711
1967-8	1378	1561	1927	750	18960	1968	712
1968-9	1759	1925	2088	917	22065	1969	715
1969-70	1582	1836	2118	858	21792	1970	773
1970-1	1723	1900	2180	881	22675	1971	817
1971-2	1935	2290	2392	1013	24462	1972	852
1972-3	2115	2481	2702	1076	26645	1973	830

Sources: MPC figures are from annual reports of Montana Power Company filed with the Federal Power Commission. All other figures are courtesy of the Northwest Power Pool Coordinating Group.

TABLE 2-4

ESTIMATED ANNUAL AVERAGE ENERGY SALES TO ULTIMATE CUSTOMERS

YEAR	PSP&LC	PGEC	PP&LC	WWPC	MPC	NWPP[1]
Actual 1973	1052	1225	1635	542	485	
Projected[2] 1973	1071	1278	1648	540	502	17553
Projections						
1974	1162	1377	1747	563	520	18385
1975	1260	1484	1851	586	639	19256
1976	1367	1599	1962	610	658	20169
1977	1482	1724	2079	636	678	21125
1978	1607	1858	2203	662	698	22127
1979	1743	2002	2334	690	719	23175
1980	1890	2158	2474	718	741	24274
1981	2049	2325	2621	748	763	25425
1982	2222	2506	2778	779	786	26630
1983	2410	2701	2944	811	810	27892
1984	2613	2910	3120	845	835	29214
1985	2834	3137	3306	880	861	30599
1986	3073	3380	3503	917	888	32049
1987	3333	3643	3712	955	915	33568
1988	3614	3926	3934	994	944	35159
1989	3919	4231	4169	1036	974	36826
1990	4250	4560	4418	1079	1004	38571
1991	4608	4914	4681	1123	1036	40391
1992	4997	5296	4961	1170	1069	42315
1993	5419	5707	5257	1218	1103	44320
1994	5876	6151	5571	1269	1138	46421
1995	6372	6629	5904	1322	1174	48622

[1] NWPP figures have been adjusted forward 6 months to be on a calendar year.

[2] 1973 projections have been derived from application of the same formula to historical data beginning in 1968

TABLE 2-5

ESTIMATED PEAK DEMAND FOR FIVE APPLICANT COMPANIES AND NORTHWEST POWER POOL
(MW)

YEAR	PSP&LC	PGEC	PP&LC	WWPC	MPC	NWPP
1974	2301	2569	2709	1072	880	27563
1975	2495	2769	2869	1116	1011	28870
1976	2707	2983	3042	1162	1043	30238
1977	2935	3216	3223	1211	1077	31672
1978	3182	3459	3416	1261	1111	33174
1979	3451	3735	3619	1314	1147	34745
1980	3743	4026	3836	1368	1184	36393
1981	4057	4338	4064	1423	1221	38118
1982	4400	4675	4307	1484	1260	39925
1983	4772	5039	4564	1545	1301	41817
1984	5174	5429	4837	1610	1343	43799
1985	5612	5853	5126	1676	1387	45876
1986	6085	6306	5431	1747	1433	48049
1987	6600	6797	5755	1819	1478	50327
1988	7156	7325	6099	1893	1527	52712
1989	7760	7894	6464	1973	1578	55211
1990	8416	8507	6850	2055	1629	57828
1991	9125	9168	7257	2139	1683	60556
1992	9895	9881	7691	2229	1739	63441
1993	10731	10647	8150	2320	1796	66447
1994	11636	11476	8637	2417	1856	69597
1995	12618	12368	9153	2518	1917	72897
Average Load Factor	0.505	0.536	0.645	0.525	0.591	0.667
Maximum Deviation Above Average	13%	9%	7%	7%	5%	3%

Notes: Average load factor applied to figures in Table 2-4 Average load factor calculated from Table 2-1 and Table 2-3 using the following time spans: PSP&LC, PGEC, PP&LC and WWPC peaks from last five operating years compared to average energy figures from last five calendar years; MPC, from Table 2-1 and Table 2-3 , 1968-1972 (1975-1995 adjusted for Anaconda contract); NWPP, from Table 2-1 and Table 2-3, 1968-1969 to 1972-1973. Maximum deviation above average is for same time span.

criterion is a commonly used criterion of best fit.

The first two rows of figures for the five applicant companies in Table 2-4 are both for the year 1973. The first figure ("Actual") is the sales experienced for that particular company in 1973. The second ("Projected") is the figure that would have been predicted by the equation that was used to project sales through 1995.

The projections of peak demand are shown in Table 2-5. Peak figures were estimated by using an average of the annual load factors experienced since 1968 for each of the five companies and the NWPP. The average load factor was divided into the average sales figures in Table 2-4 to yield the estimated peak figures shown in Table 2-5. The last line in Table 2-5 ("Maximum Deviation Above Average") shows the maximum amount by which recorded peaks would have exceeded estimated peaks using the average load factor and average sales to estimate 1968-1973 peak demand.

2.2.1. NWPP Sales and Resources

The equation which best fits the NWPP average data for the period from the 1968-1969 operating year to the 1972-1973 operating year is $Y_i = (14{,}251)(1.0474)^i$, where Y_i is the average sales in the i=th year; i=o is the year 1968-1969. The figures shown in Table 2-4 have been adjusted forward six months to put them on a January 1 to December 31 calendar year basis. Figures from Tables 2-4 and 2-5 are shown here for select years:

Year	Average Sales (MW)	Peak Load (MW)
1975	19,256	28,870
1980	24,274	36,393
1985	30,599	45,876

As of December 31, 1973, the installed peak capability of the NWPP was 34,032 MW. Of this total 28,501 MW was hydro, 4,662 was fossil, and 860 MW was nuclear capacity. Planned additions to be brought on line between now and the end of 1980 will increase total capacity to 50,938 MW (36,818 hydro, 9,770 fossil, and 4,350 nuclear). Further additions planned to be brought into service between 1980 and 1985 will bring total capacity to 58,159 (37,934 hydro, 10,685 fossil, and 9,540 nuclear). These figures (NWPP 1974) do not include Colstrip Units 3 and 4, but do include Units 1 and 2. They also assume no retirements of existing capacity between now and 1985.

The average and peak figures do not include line losses, nor do the capacity figures consider scheduled and non-scheduled maintenance or critical water conditions for hydro generation.

2.2.2. Projections Used for the Four Pacific Northwest Applicants

2.2.2.1. Puget Sound Power and Light Company

PSP&LC sales to ultimate customers have been estimated by the equation $Y_i = (714.788)(1.0844)^i$ with i=o in the year 1968. PSP&LC has had the fastest rate of growth experienced by any of the applicants over the 1968 to 1973 period. PSP&LC figures for selected years from Tables 2-4 and 2-5 are shown here.

Year	Average Sales (MW)	Peak Load (MW)
1975	1,260	2,495
1980	1,890	3,743
1985	2,834	5,612

As of 1974, PSP&LC owned 525 MW of capacity and purchased an additional 1,694 MW (PSP&LC 1974) of publicly owned capacity under long term contracts. Capacity presently under construction or in the planning stage will add 1,742 MW by 1985, which would bring total owned and purchased capacity to 3,961 MW in 1985. These figures do not include Colstrip Units 3 and 4.

2.2.2.2. Portland General Electric Company

The equation of the best fit exponential curve derived from the PGEC data for 1968-1973 is $Y_i = (878.995)(1.0777)^i$ where Y_i is the average sales to ultimate consumers in the i.th year, with $i=o$ being 1968. Bringing forward the same three projected years from Tables 2-4 and 2-5 yields the following:

Year	Average Sales (MW)	Peak Load (MW)
1975	1,484	2,769
1980	2,158	4,026
1985	3,137	5,853

Existing capacity owned by PGEC is 1,162 MW; there is 1,202 MW of capacity under construction and another 1,449 MW (excluding Colstrip Units 3 and 4) of capacity in the planning stage (PGEC 1974). Assuming no retirements of existing capacity, total capacity will be 2,651 MW by 1985.

2.2.2.3. Pacific Power and Light Company

PP&LC shows the most even growth pattern of any of the five applicant companies. This is probably a result of the geographic diversity included in its service areas. The exponential equation used to project PP&LC sales to ultimate consumers is $Y_i = (1,233.590)(1.0597)^i$. Three projected years are shown below.

Year	Average Sales (MW)	Peak Load (MW)
1975	1,851	2,869
1980	2,474	3,836
1985	3,306	5,126

Existing capacity owned by PP&LC as of December 31, 1973, was 2,347 MW. In addition to this installed capacity, there are units either under construction or planned for installation by 1985 that amount to 3,514 MW exclusive of Colstrip Units 3 and 4. Combined capacity will be about 5,861 MW by 1985, assuming no retirement of existing capacity.

2.2.2.4. Washington Water Power Company

The best fitting exponential equation for the WWPC sales to ultimate customers data for 1968-1973 is $Y_i = (44.883)(1.0415)^i$. Peak and average use figures for selected years from Table 2-4 and Table 2-5 are shown below.

Year	Average Sales (MW)	Peak Load (MW)
1975	586	1,116
1980	718	1,368
1985	880	1,676

WWPC owns 925 MW of existing capacity and is expected to receive an additional 194 MW of capacity planned for construction (WWPC 1974), bringing total capacity to about 1,120 MW by the mid 1980's.

2.2.3. Montana Power Company

Projections for MPC are derived from the exponential equation $Y_i = (422.868)(1.0351)^i$. This equation is based on the 1968-1973 sales to ultimate customers data. Starting in 1975, an additional 101 MW is added to the estimate made by the above equation. This 101 MW covers the Anaconda Copper Mining Company (ACM) increase in load and is added to both average sales and peak load figures. This assumes a 100% load factor. Figures from Tables 2-4 and 2-5 are shown below.

Year	Average Sales (MW)	Peak Load (MW)
1975	639	1,011
1980	741	1,184
1985	861	1,387

Compared to these load projections, existing peak capacity is currently 768 MW. Units 1 and 2 will add a total of 330 MW to MPC capability by 1977, at which time total capability will be 1,098 MW. A more thorough comparison of MPC resources to load will be made below (Section 2.4.), but a closer look at the projected load figures and the basis (historical data) for these MPC projections is necessary first.

Of the five applicant companies, MPC presents the most erratic sales history. Much of the variation is due to the ACM load and the relative proportion of the ACM load to the total system load. A few examples of the peculiarity of the MPC data are listed here:

1) For the 11 years that data on the sales to ultimate customers were used (1963 to 1973, inclusive), three of the 10 possible years showed sales of less than the previous year (1967, 1971, 1973).

2) Use of different time periods gives quite different results. For example, consider the following time periods and average growth rates:

1963-1973	4.3%
1968-1973	3.9%
1970-1973	1.1%

3) If one were to look only at the data for either the 11 years (1963 to 1973, inclusive) or the six years (1968 to 1973, inclusive) and fit curves to that data, the surprising result emerges that, for both time periods, a straight line fits the data better than an exponential curve. The difference between the two lines for projection purposes is enormous, and increases with time.

Even more surprising is the result that emerges if the years of labor strikes at the ACM are deleted from the data (1967, 1968, 1971). This was done to "explain" why the exponential growth equation did not fit the data as well as a straight line. However, once these abnormal years are removed, the pattern of the data points indicates a curve that is concave downward; i.e., the growth is progressively smaller in each successive year. The reader can see this by covering up the points for 1967, 1968 and 1971 in Figure 2-1.

4) The historical data broken down between industrial, residential and commercial sales shows residential and commercial growing quite smoothly at about 5½% and 7%, respectively. The industrial load is not only the most erratic (e.g., industrial sales were larger in 1966 than in 1973) but also the largest, accounting for 50% of the total sales to ultimate customers in 1973. Projecting for industrial sales alone is very uncertain.

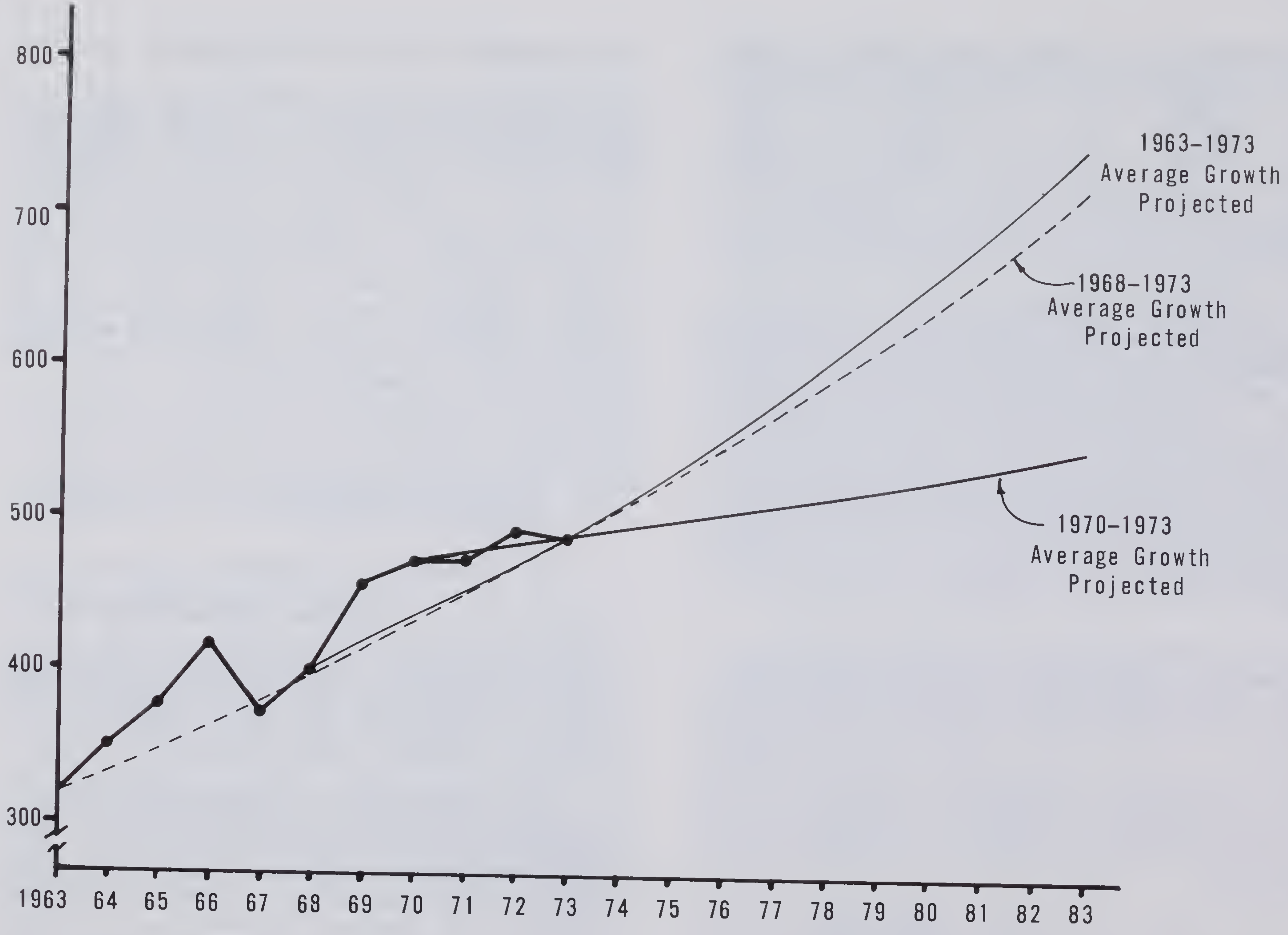
The data and the resulting average growth rates (point 2 above) are plotted in Figure 2-1. The three growth rates are extended forward ten years to demonstrate the significance of the differences.

The projections used for MPC are shown graphically in Figure 2-2, which illustrates 1) the sales to ultimate customers data, 1963-1973; 2) the basic projection curve $Y_i = (422.868)(1.0351)^i$ for 1968 to 1991; 3) the basic projection plus 101 MW (ACM) superimposed over that curve from 1975 forward; and 4) a hypothetic 5½% growth curve projected from 1963 forward. The 5½% figure is often used by MPC when speaking of its current growth rate (MPC 1974). Figure 2-2 shows what sales to ultimate customers would be if growth were at 5½% since 1963.

2.3. Historical Projections (Will the Future Conform to the Past?

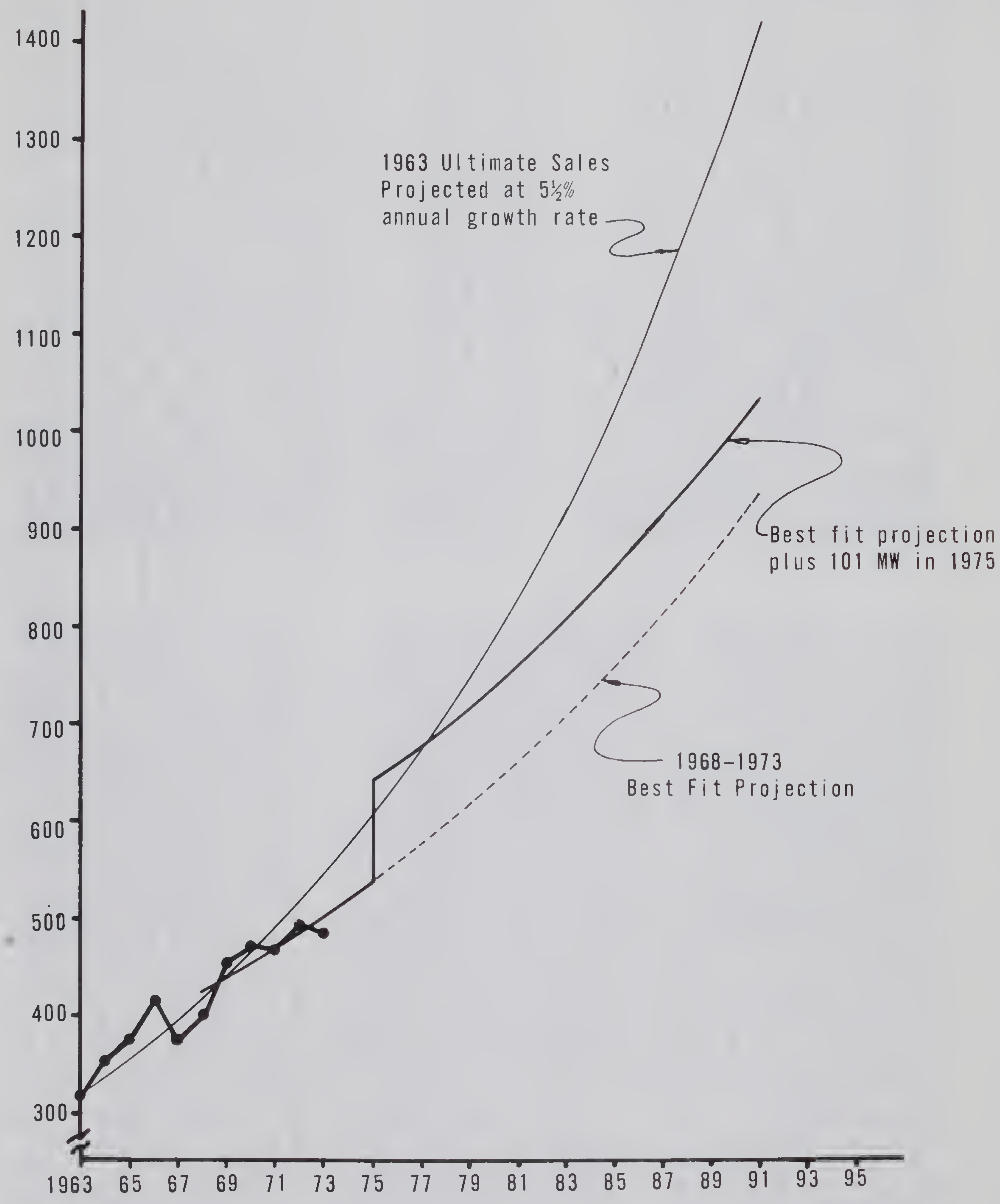
In Section 2.2. projections were made based on the past five or six years' data. The only adjustment made was the addition to MPC projections of the ACM load expansion in 1975. In this section underlying determinants of electric usage will be briefly discussed, together with estimates of how some of these factors may be expected to change in the years ahead.

The assumption that the growth of electric consumption is a function of time itself must be rejected; electric consumption growth is a function of a number of variables, many of which have changed with the passage of time in a direction favorable to increased consumption. Even a partial list would include increases in population and income (both total and per capita). Less obvious is the drop in the real price (adjusted



Sales to Ultimate Customers; Historical Data 1963–1973
Projections to 1983 Based on Most Recent 3, 5 and 10 Years Data
Montana Power Company

FIGURE 2-1



Projections MPC Average Sales to Ultimate Customers

FIGURE 2-2

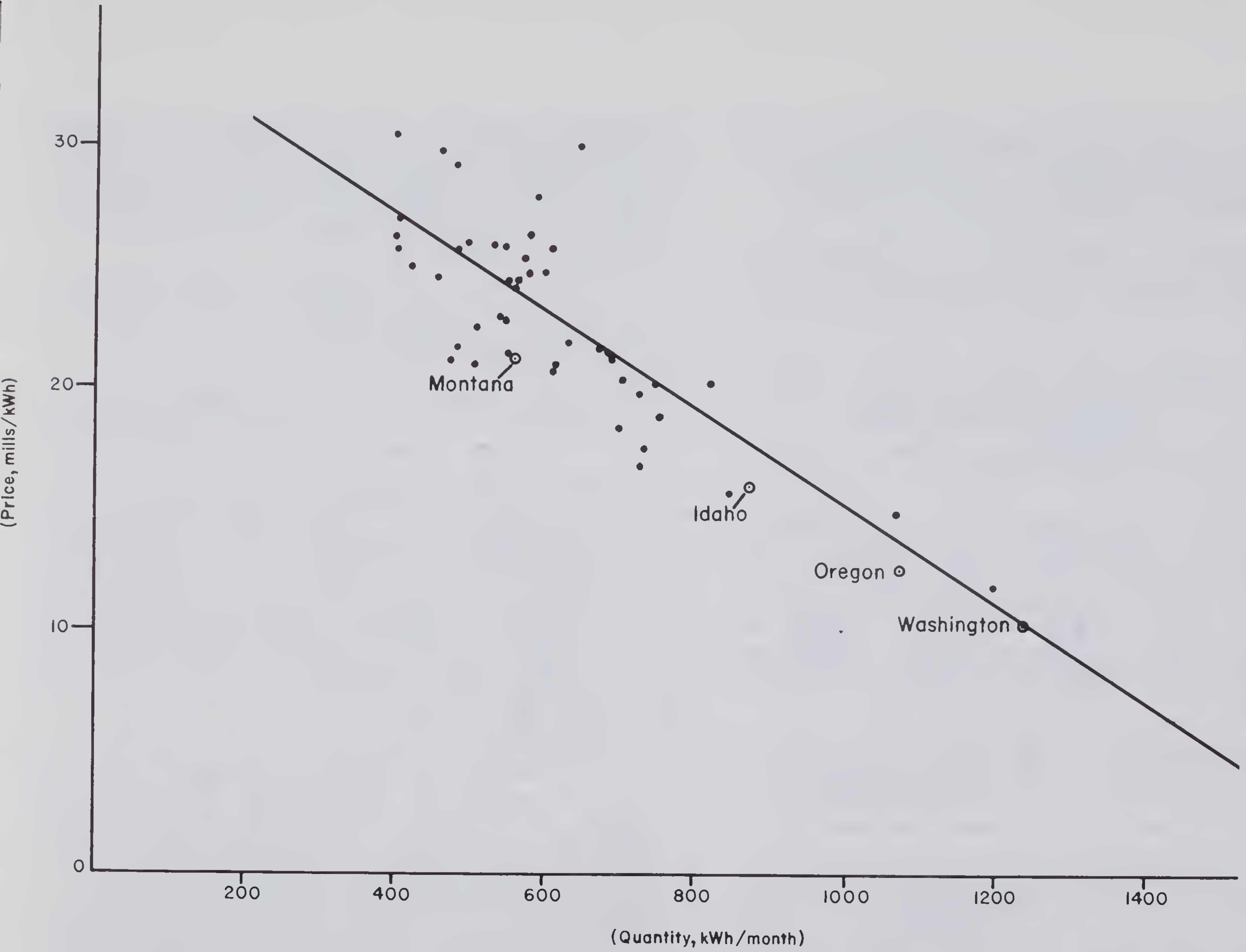
for general price level changes) of electricity at least until the late 1960's, while the prices of all fuels have been rising since before World War II (BPA 1973). In addition to these factors, which have shown steady movement through time, variations of weather could affect any given year significantly, but, unless long term climatic changes are assumed, should not have a cumulative effect. Promotional advertising may also have sporadic or even long-term effects, but how cumulative those impacts are is uncertain.

In contrast to the past record, many determinants of electric energy consumption are expected to move in directions less favorable to expanded consumption in the future. Real Gross National Product (GNP) has shown an absolute decline in each of the first three quarters of 1974, and no serious analysts predict anything like the growth rate of the past 10 years to be repeated in the next 10 years. Recent population projections of the Bureau of Economic Analysis (U.S. Department of Commerce 1973) show a growth rate over the 1970-1990 period of only 60% of what it was between 1950 and 1970.

While population growth and production increases appear to be lagging far behind the recent past historical rates, the changes in the price of electricity have been upward since the late 1960's, after years of decline. Further, it is expected that increasing prices for electricity are going to continue in the future. These increased prices will result from many causes, including tougher environmental legislation, increased fuel costs, dilution of low cost hydro systems with more thermal capacity, and extremely rapid increases in costs of plant equipment. The responsiveness of consumption levels to price changes may be especially crucial if two tier pricing as considered by the Bonneville Power Administration (BPA) were ever instituted (BPA 1973). Under such a scheme, the full costs of new generation would be passed on only to those customers whose increased consumption necessitated new facilities, rather than having all customers share the average costs of all generation equally. This would have substantial impacts in the Northwest where low cost hydro generation presently dominates the installed generating capacity; additions to capacity will be heavily made up of higher cost steam units, such as Colstrip Units 1 and 2.

There is a great deal of controversy over the responsiveness of the demand for electricity to changes in its price. Figure 2-3 demonstrates the strong relationship between price and consumption, with consumption being highest in those states with the lowest prices, both national and in the Northwest.

At present the costs of electricity, gas and oil seem to be rising quite rapidly. Oil prices increased drastically during the past winter as a result of price hikes by the major oil exporting nations, but the rate of increase now has evened out again. As a nation we have gone from a long period of restricting imports to protect our domestic oil producers to currently facing oil shortages. These shortages are not caused by the depletion of world supplies, but rather by a cartel thus far successfully run by the exporting nations. The long run outlook for oil prices is uncertain. At times in the past three months there has been an excess supply of oil in world



RESIDENTIAL ELECTRICITY, 1971
(Price and Consumption by State)

Data Source: Impact Study: BPA Proposed Rate Increase
Bonneville Power Administration, November 1973

FIGURE 2-3

markets at the posted prices. Recurrence of such excesses would probably weaken the solidarity of the cartel. Increased oil production in the U.S. and the North Sea would have the same effect.

Turning to natural gas, shortages could prove to be rather temporary. Although the logic of finite world reserves of oil and gas is impeccable, it may also be irrelevant over the next 30 years. Many studies indicate that the current shortages are not due to lack of physical resources in the ground; they are due to either insufficient investment in the discovery of new reserves or the withholding of known reserves in expectation of higher future prices.

MacAvoy and Pindyck (1973) in reference to natural gas indicate that the "shortages" could be eliminated by 1979 and that a "surplus" could be brought into existence in 1980 by government policies which allowed the price of natural gas at the wellhead to increase slightly faster than the Federal Power Commission allowed between 1970 and 1973.

The end result of the increase in prices of all energy forms is uncertain, particularly in light of the uncertainty regarding relative price changes between energy forms. Increases in the prices of all forms of energy relative to general price levels will tend to dampen the growth rates of total energy consumption. This effect will decrease the gains in consumption of one source of energy that might be substituted for another; it will conversely increase the losses felt by energy sources for which alternate energy forms are substituted. Although the time span is too short to draw definite conclusions, recent nation-wide growth of electric sales has dropped off sharply, with the total sales for the first six months of 1974 being only 0.3% above sales for the same period last year (Bailey 1974). During this period, the price of both electricity and oil increased.

Chapman et al. (1972), in concluding their statistical study of future national demands for electric energy, argued:

> "The estimates...suggest a hierarchy of importance of the four factors [influencing electrical demand]. The most important factor seems to be the price of electricity, followed by population growth, income, and gas prices in order of decreasing importance. While modification of these estimates is certain, we believe that future amendments will be of a small magnitude. The estimates indicate that substantial cost increases...and a reduction in population growth will noticeably lower electricity demand growth in the 1980's and 1990's..." (p. 705).

Although most of the discussion has been from a nationwide perspective, the outlook for growth in electric consumption for Montana is probably even less encouraging. Recent projections by the Bureau of Economic Analysis of the Department of Commerce (Survey of Current Business 1974) project a loss of 39,000 people between 1971 and 1980 and an additional loss of 5,000 by 1990. Although these figures do not appear to reflect the full influence of coal development in eastern Montana, a recently completed study (Polzin 1974) on eastern Montana projects that by 1985 increases in population associated with coal development will be about 30,000 people. This estimate assumes that both Units 3 and 4 plus another 1,000 MW of capacity are built. In addition this estimate includes the assumptions that two 250 million standard cubic feet (MMscf) gasification plants will come on line by 1985 and that up to 50 million tons of coal will be mined solely for export. If this 30,000 is added to the Department of Commerce projections, the result is still a population decline of between 10,000 and 15,000 by the 1985-1990 period.

The outlook for an increased economic growth rate in Montana is as doubtful as that for increased population. The 1970 Montana Economic Study by the University of Montana Bureau of Business and Economic Research projected slower growth rates of employment and personal income during the period from 1968 to 1980 that occurred in the 1960's (p. 1.20 - -1.24). This projection was against a background 4.2% expected annual rate of increase in GNP for the same period, which now, with the benefit of hindsight, would probably call for further downward adjustment in the Montana projections.

The outlook for changes in the price of electricity in Montana and the Pacific Northwest is that prices will rise substantially. We may be in a better position than the rest of the nation due to the availability of coal, but new thermal generating units, whether nuclear or coal fired, are going to be more costly to build and operate than existing hydro plants. Relative to current electric rates, increases here may be as rapid as increases in the rest of the country.

In conclusion, consideration of underlying determinants of electric consumption and their probable direction of movement over the next five to fifteen years gives little reason to adjust the historic projections (Tables 2-4 and 2-5) upward; the outlook for these determinants is, in fact, more supportive of a downward adjustment.

2.4. Projected Consumption Compared to Present and Projected Capability

The evaluation of present and planned capability as compared to the projected demand for electricity has been undertaken for the NWPP area and for the four out-of-state applicants in only a very general way. Whether the projected levels of consumption in the Northwest can be met without Colstrip Units 3 and 4 has not been examined closely. However, these units would provide balance to a system that is predominately made up of hydro generation. The vulnerability of hydro generation in dry years was demonstrated in 1972 and 1973, and the producing agencies and companies in the region are very aware of their vulnerability.

2.4.1. Montana Power Company Consumption and Capability

Dealing with the single entity represented by the MPC system simplifies comparison of electric consumption and capability greatly. This system must be given additional weight, since a Montana generating site must be considered more important to MPC than to its partners farther west.

Present generating capacity of MPC amounts to 711 MW (name plate rating). Capability (potential output for periods of one hour or less) is listed as 768 MW (Annual Report of MPC 1973). This capacity is composed of 246 MW of steam generation, 2.75 MW of internal combustion, and 520 MW of hydro plant. Table 2-6 includes a more complete listing.

During 1973 the average load was 69% of name plate capacity, with the two steam generating plants currently in service, the Corette plant and the Bird plant, operating at a 68% and a 17% load factor, respectively. Average output from the hyro units in 1973 was 77% of name plate capacity (calculated from MPC Annual Report to the Department of Public Service Regulation).

In July of 1975 and July of 1976, Colstrip Units 1 and 2, respectively, are scheduled to come on-line. MPC owns one-half interest in each of these units, and so will experience an increase of 330 MW of additional capacity by mid-1976. Total capacity will then be 1041 MW.

A comparison of capacity (without Units 3 and 4) and consumption is made in Table 2-7. Projections of both average sales to ultimate customers and peak demand are brought forward from Table 2-4 and Table 2-5. Peak capability starts with the present 768 MW and adds 165 MW in both 1975 and 1976. These additions represent MPC's share of capacity from Colstrip Units 1 and 2.

The last column of Table 2-7 shows the average resources owned by MPC under conditions of critical water. Critical water depicts the worst water conditions that can be reasonably expected based on historic hydrologic data. MPC uses the 1928-1932 period for the Columbia Basin and the 1934-1938 time span in the Missouri Basin to simulate critical water (Blankmeyer 1974). The monthly critical water potential energy generation figures yield an annual average generation under critical conditions of 337 MW, or approximately 72% of name plate capacity of the hydro generating units. In addition to the hydro figure, the Corette plant is assumed to operate at an 80% load factor (138 MW), and the Bird plant is assumed to operate at a 50% load factor (33 MW). This is at a load factor above recent experience for the Bird Plant, but is probably a conservative estimate of how it would be operated in a critical water year. Units 1 and 2 are assumed to operate at an 80% load factor once their initial shakedown period is passed.

The figures in Table 2-7 do not include any purchases or exchanges of power, which are an ongoing part of the picture.

MPC does have a number of long term contracts for both purchase and exchange of energy and capacity. Most are relatively small in size, but two are large enough to warrant consideration here. One is with BPA, calling for delivery to MPC of 50 MW of peak and 40 MW of average energy through August 1987. The second contract, between MPC, BPA and the Washington Public Power Supply System, will add 80 MW of peak and 68 MW of average energy to the MPC system resources start-

TABLE 2-6

MONTANA POWER COMPANY GENERATING PLANTS

PLANT (NAME)	KIND OF PLANT STEAM, HYDRO OR INT. COMB.	CAPACITY KW. (NAME PLATE)	CAPABILITY KW.*
Black Eagle	Hydro	16,800	18,000
Cochrane	"	48,000	50,000
Flint Creek	"	1,100	1,100
Hauser Lake	"	17,000	16,500
Holter	"	38,400	49,000
Kerr	"	168,000	180,000
Madison	"	9,000	8,500
Milltown	"	3,040	3,400
Morony	"	45,000	47,000
Mystic Lake	"	10,000	11,500
Rainbow	"	35,600	35,000
Ryan	"	48,000	60,000
Thompson Falls	"	30,000	40,000
Frank Bird	Steam	66,000	66,000
J. E. Corette	"	172,800	180,000
Lake Diesel, Yellowstone Nat'l Park	Internal Comb.	2,750	2,750
TOTAL	Hydro	469,940	520,000
	Steam	238,800	246,000
	Internal Comb.	2,750	2,750
TOTAL ALL PLANTS		711,490	768,750

*That load which can be safely carried for a period of 1 hour without exceeding any of the physical limitations of the equipment such as operating temperature or voltage maintenance.

SOURCE: Annual Report of Montana Power Company to the Montana Department of Public Service Regulation.

TABLE 2-7

MPC PROJECTED LOADS AND COMPANY OWNED RESOURCES, 1974-1983

All Figures in Megawatts

Year	Projected Peak Demand	Peak Capacity	Projected Average Load	Resources Under Critical Water Assumptions
1974	880	768	520	508
1975	1011	933	639	640
1976	1043	1098	658	772
1977	1077	1098	678	772
1978	1111	1098	698	772
1979	1147	1098	719	772
1980	1187	1098	741	772
1981	1221	1098	763	772
1982	1260	1098	786	772
1983	1301	1098	810	772

Sources: Load projections are from Tables 2-4 and 2-5

Peak capacity includes ½ of Unit 1 (1975) and ½ of Unit 2 (1976) ing in 1980 and ending in 1996.

These two contracts are included in the MPC resources shown in Table 2-8. Table 2-8 demonstrates that by 1985, MPC is in a deficit position where average resources will not cover average projected load. Peak load passes peak resources before then, but this might be covered by purchases or trades of power. It should be noted that utilities do not build peak load capability into their individual systems, but instead rely on interconnected systems to balance the peak load between various areas or regions.

Before a conclusion on need in the MPC system can be reached, another few factors must be considered.

The first step is to equate projected consumption with need. There is no definitive answer to the validity of this equation, but in fact the question may not have to be addressed. Assume for the moment that projected consumption is defined as being equal to need. Table 2-8 does demonstrate the need for additional generating capacity in the mid 1980's, but the amount would be less than the 1400 MW generated by Units 3 and 4, and other alternatives exist for meeting this demand.

For example, MPC had suggested that:

> If Unit Nos. 3 and 4 are not built as proposed by the Applicants, the Montana Power Company is considering construction of a third 350 megawatt or larger unit to be constructed at Colstrip in 1979, and additional generation, probably gas turbines of 150 megawatt capacity, would be required somewhere on The Montana Power Company System to meet generation requirements by December, 1978 (MPC, 1974 p. 2-3).

Looking beyond the MPC system to a consideration of the needs and resources of the entire state, the picture is similar. Load growth has been slow, especially in the period since 1968. As can be seen in Table 2-9, the 1969 sales to ultimate customers were more than the sales experienced last year. Sales have remained at essentially the same level since 1969, a phenomenon very dissimilar to the nationwide trend. In-state generation has been appreciably higher than in-state sales.

TABLE 2-8
MPC PROJECTED LOADS AND RESOURCES, COMPANY OWNED PLUS TWO EXISTING MAJOR CONTRACTS, 1974-1986
All Figures in Megawatts

Year	Projected Peak Demand	Peak Resources	Projected Average Load	Average Resources Under Critical Water
1974	880	818	520	548
1975	1011	983	639	680
1976	1043	1148	658	812
1977	1077	1148	678	812
1978	1111	1148	698	812
1979	1147	1148	719	812
1980	1187	1228	741	880
1981	1221	1228	763	880
1982	1260	1228	786	880
1983	1301	1228	810	880
1984	1343	1228	835	880
1985	1387	1228	861	880
1986	1433	1228	888	880

Sources: Load projections are from Table 2-4 and 2-5
Resources include 1/2 of Unit 1 (1975) and 1/2 of Unit 2 (1976)plus two existing major purchase contracts. Average resources assume steam generating units at 80% load factor except for the Bird plant, assumed at 50% load factor during a critical water year.

TABLE 2-9

Average Generation and Sales to Ultimate Customers by Year, 1961-1973, State of Montana

Year	Average Sales (MW)	Average Generation (MW)
1973	978	1,042
1972	1,049	1,220
1971	1,052	1,216
1970	1,038	1,145
1969	1,045	1,192
1968	884	1,084
1967	784	1,041
1966	808	983
1965	711	1,014
1964	645	840
1963	593	753
1962	576	805
1961	545	774

Installed capacity in the State of Montana as of 12-31-72 was 1,882 MW.

Sources: Computed from Edison Electric Institute, Statistical Year Book of the Electric Utility Industry for 1971 and 1972; Edison Electric Institute, Historical Statistics of the Electric Utility Industry Through 1970; Personal Communication, Dave Bailey, Statistics Section, Edison Electric Institute, 1974

Generating capacity sited in Montana amounted to 1,882 MW as of December 31, 1972. The addition of Units 1 and 2 at Colstrip, plus the completion of the first four units at Libby, will increase in-state generating capacity by approximately 1,080 MW, giving Montana 2,962 MW of installed capacity by mid-1976. Four more units are scheduled for installation at Libby by late 1993, adding another 420 MW to generating capacity for the State of Montana. At that time capacity at Libby would probably be used as peaking capacity.

The above analysis of need is preliminary. Further studies are under way which will be published in the final EIS.

CHAPTER THREE Alternative Electricity Sources

The distribution of future electric growth between the various electricial energy sources (i.e., coal fired, nuclear, hydro) is a complex national and regional issue which requires in-depth study at the federal level. Therefore, the Energy Planning Division will not attempt to justify the applicants' preference for coal fired power plants over nuclear and hydro plants.

A comparison of eleven (11) alternative electricity sources was conducted and revealed that the available practical electricity sources for large scale (500 MW and above) commercial size generating plants are not too numerous. For various reasons, gas-oil turbine units, geothermal units, nuclear breeder units, solar power, wind power, tidal power, magnetohydrodynamics (MHD) units and nuclear fusion units are not viable electricity sources for this region at this time. These sources considered viable alternatives are nuclear fission units, coal fired units and hydroelectric units. Table 3-1 summarizes the three most practical and presently available sources of electrical power for this region.

TABLE 3-1

SUMMARY OF ALTERNATIVE ELECTRIC POWER SOURCES.

Electricity Source	Time Constraints	Total Approximate Construction Cost	Approximate Operational Cost Fuel	 Others
Nuclear	8 to 10 years planning; probably 4 to 6 years construction time	around $500 /kw	1 to 3 mills per kwh	1 mill per kwh
Hydro	Around 4 to 6 years, depending on site availability	$200 /kw to $1,000 /kw	None	Less than 1 mill per kwh
Coal-fired	Around 6 year lead time, with 3 to 4 years construction time.	around $250 /kw to $400 /kw	3 to 5 mills per kwh	2 mills per kwh

TABLE 3-1 (cont.)

Approximate Plant Site Requirements	Possible General Impacts
300 to 900 acres	Construction crews of approximately 2000 to 3000 men and their families could impact the local communities. The potential for environmental impact is great (i.e. in case of nuclear accident). Actual air pollution probably is less than coal fired. Actual thermal pollution would be about 50% more than coal fired.
quite variable and very limited choice	The construction crews and their families could impact the local communities quite heavily for periods of three to four years. Probably the greatest impact from hydro plants would be to the river itself and the riparian lands along the river. Air pollution would be negligible or non-existent, and thermal pollution would be negligible.
700 to 1,200 acres	The impact on local communities could be very significant due to the large construction crews of 1000 to 3000 men and their families for periods of three to four years. Actual air pollution from coal fired plant combustion gases is the single most impacting factor. Also, the thermal pollution and water consumption are causes of impact.

CHAPTER FOUR Alternative Coal-Fired Plant Sites

The selection of an optimal site for a coal-fired power plant is based on a number of criteria. These are the cost to the utility, social and economic costs to local communities, environmental costs, and engineering factors. An optimal site exists for each of these criteria, but usually no single site can equally satisfy all of them. Therefore, trade-offs between the criteria must be made in deciding upon a location.

In the case of the Colstrip project, a regional option exists for relocating the proposed facilities in terms of all of the above criteria. However, the particular emphasis in this chapter is the cost to the utility companies and the cost to their customers. This emphasis will be limited to a consideration of the comparative dollar costs of mine site generation, in which the electric energy is transmitted via EHV transmission lines to the load center, versus load generation, in which the coal itself is transported to the load center and used there to fuel the generating units. In the case compared below, the applicants' proposal for building Units 3 and 4 in Colstrip, Montana, and shipping the power west by means of two parallel 500 KV lines (mine site generation) is weighed against the alternative of not building the units in Colstrip, and instead shipping the equivalent amount of coal westward to units built closer to the load centers (load center generation). Narrowly defined, the question is simply which alternative costs less.

4.1. Comparisons of Alternative Costs: Coal Shipment Versus Electric Power Transmission

Although the question appears to be simple, it involves other questions: How can costs of alternatives be compared if the timing of expenditures is different? From whose point of view should the costs be compared? Is it cost to the company or cost to the customer that counts? These questions present themselves in any serious cost comparison, and, although not all of them will be answered, an attempt will be made to consider the most important question areas.

4.1.1. Costs of Service to the Consumer

4.1.1.1. Introduction

Both common sense and economic theory indicate that, generally speaking, increased costs of production are, at least in part, passed on to the consumer. In the United States, public utility monopolies are regulated at both the state and the federal level, with the responsibility for intra-state regulations falling to the state regulatory commission. By law, utilities are constrained to charge customers rates that will earn the utility no more than a "fair" rate of return on investment. This leaves two areas of ambiguity for the state regulatory commission: 1) what is the "fair" rate of return, and 2) what is allowed in the "investment" on which the rate of return is calculated?

Generally, the rate of return is supposed to approximate the rate of return earned on other investments of similar risk. The "investment" is commonly called the rate base (the base to which the fair rate of return is applied). Expense items such as fuel and labor (items that are "used up" in the same year that they are purchased) are not allowed in the rate base, but are passed on directly to the customer without the utility earning a return on them. Capital items such as generators, transformers, and transmission lines (items that last beyond the year in which they are purchased) are allowed into the rate base, and their cost _plus_ a fair rate of return on that cost is charged to the customer over the life of the capital item.

From this it follows that two alternative expenditures of funds might have quite different impacts on the allowed revenues of the utility depending on whether the expenditure was allowed into the rate base or not. The case in question, building and operating transmission lines versus shipping the coal, involves different avenues of regulatory accounting. If the transmission lines are built, the total cost of the construction of those lines plus an allowance for interest during construction (an allowance to cover capital investment made, but not yet entered into the rate base) will become a part of the total rate base upon the completion and energization of those lines. Thus over the life of the line, the customers will pay an amount equal to the annual depreciation charges to the line and other associated expenses _plus_ a rate of return on the investment. If, in contrast to this capital expenditure, the coal is shipped, the cost of shipping will be treated as an expense item not allowable into the rate base, and no rate of return will be allowed on it. The expense will merely be passed on to the customer. For equal annual expenditure by the utility, the customer will normally pay more for the transmission line alternative than he will if the coal is shipped. This is generally true when comparing any expense item to a capital item.

4.1.1.2. Cost Comparisons

The following cost-estimating procedures are applied to a hypothetical case in which coal is shipped from Colstrip to Hot Springs in lieu of building transmission lines from Colstrip to Hot Springs. This should not be taken as a proposal that Units 3 and 4 be built at Hot Springs; it is rather a small part of the overall comparison of load center versus mine mouth generation, assuming the actual load center is west of Hot Springs. The Colstrip to Hot Springs segment is the only portion of the area under consideration which would be totally in the hands of private companies, and for which considerations of load displacement play no signficant part. From Hot Springs west, the Bonneville Power Administration (BPA) grid would be utilized, and the combination of private and public ownership would be difficult to untangle in terms of costs to the consumer. The Spokane, Washington, area is considered as a comparison point in Section 4.1.2., but the methodology of that comparison is different.

The calculation of the cost of electric transmission involves identifying and estimating the magnitude of all factors which will influence the cost of electricity to the consumer. Thus any charges which are allowable operating expenses for public utilities must be included, as well as a reasonable rate of return for the capital costs of the project. In addition, a cost is incurred when electricity is generated and then lost via transmission because of the resistance of the line; the opportunity cost of these line losses--their value in an alternative use--is also incorporated into the total cost of transmission. At the core of the estimate is the installed cost of the line; the relative size of that expenditure is dominant.

Six estimates were made of the cost of transmission of electricity from Colstrip to Hot Springs, Montana. Basic assumptions common to the estimates were that 1,390 MW of peak power would be available at Hot Springs with an associated line loss of 64 MW of peak power (Davenport 1974). Load factors used are shown in Table 4-1, showing that as the Colstrip generating facilities age and are replaced by more modern equipment, their average load falls. This is consistent with cost procedures established by the Federal Power Commission:

> A basic premise used in the estimates was that over the estimated service life of 30 years the high-pressure, high-temperature plants would be operated over a range of annual plant factors, relatively high during the first half of the service life and gradually diminishing to a minimum with a lifetime average of 55 to 60%. (FPC 1968, p.88)

The load factors used in Table 4-1 yield a higher average load factor, 65%. The line and associated substations were assumed to have a useful life of 37 years. Both the higher load factor and the longer life used here result in lower costs of transmission. Because load factors vary over the age of the project, the cost of transmission in mills/kwh will also vary.

A number of estimates were made of construction costs of 500 KV lines. Using The 1964 National Power Survey and other Federal Power Commission publications, consistent estimated installed costs for 500 KV lines can be made. These figures also compare closely to BPA actual cost experience, except that the BPA recent experience shows a much faster inflation of costs than does the Handy-Whitman Index (Whitman, Requardt and Assoc. 1974). All of the FPC and BPA data are closely comparable; their differences are largely explained by differences in overhead cost loadings or variation in inflation indices. As compared to this group of estimates, the costs estimated in the Westinghouse (1973) analysis are

TABLE 4-1

LOAD FACTORS USED IN COST OF TRANSMISSION ESTIMATES

Age of Transmission Line	Peak Load	Load Factor	Average Load	Average Line Loss
1 - 9 years	1390 MW	80%	1112.0 MW	51.2 MW
10 - 16 years	1390 MW	75%	1042.5 MW	48 MW
17 - 23 years	1390 MW	65%	903.5 MW	41.6 MW
24 - 30 years	1390 MW	55%	764.5 MW	35.2 MW
31 - 37 years	1390 MW	45%	625.5 MW	28.5 MW

extremely low and have been rejected as unrealistic for rate base estimates.

Three estimates of installation costs are used here. The first uses information adapted from FPC (1969) published material. The second estimate is based on adjusted BPA data. The final estimate is an attempt to reflect possible differences in land and labor costs in Montana together with a high ratio of guyed tower structures (BPA uses more self-supported towers).

In addition to the costs of constructing the lines from Colstrip to Hot Springs, there would also be a heavy capital expenditure in substations. According to the Westinghouse (1973) analysis, substation investment associated with the lines would amount to $35,073,000. This figure is at least two years out of date now, and is definitely understated. However, it is used for all estimates in the analysis.

The total capital expenditures associated with the Colstrip to Hot Springs line estimated in the three different ways described are shown below in Table 4-2. A distance of 426 miles is used to estimate transmission line costs.

TABLE 4-2

Alternative Estimates of Costs of Double 500 KV Lines and Associated Equipment: Colstrip to Hot Springs, Mid-1974 dollars

	Transmission Lines	Substations	Total Cost
Est. 1	$161,389,248	$35,073,000	$196,462,248
Est. 2	$213,000,000	$35,073,000	$248,073,000
Est. 3	$149,100,000	$35,073,000	$184,173,000

Before discussing the calculation of customer costs, one further adjustment to the estimated capital costs must be made. Although interest payments made by the utility to bond holders are not allowable expenses for rate-making purposes, there is an allowance for interest accrued during construction of facilities. Investments in plants are not allowed into the rate base until that equipment is placed in service, which may be many years after construction was initiated, and, over the interim, interest charges accumulate. These charges are allowed to be added into the original costs of the plant. Assuming an 8% annual allowance for interest during construction, and a three-year construction time, 12% (funds tied up for an average of $1\frac{1}{2}$ years before the plant is in service) should be added to the three estimates in Table 4-2 to approximate the addition to rate base. This means estimate one would be reflected as an increase in the rate base of $220,037,718; estimate two would increase the rate base by $277,841,760; estimate three would increase the rate base by $206,273,760.

Using the construction costs described, the details of the cost calculations are explained below:

1) Rate Base. The installed cost of the transmission lines and substations plus the allowance for interest during construction enter the rate base in the same year the facility is energized. The effect of the installation on the rate base is reduced in successive years by the amount of annual depreciation expense, so that at the end of the 37-year period, original cost, less accumulated depreciation, is zero.

2) Return to Investment. Capital investment is undertaken in order to earn a profit for the owners; in a regulated industry such as a public utility, profit rates reflect the opportunity cost of alternative investments. Two rates of return estimates are used here. The low estimate uses a rate of return on invested capital of 8%, which reflects the historical rate of return of public utilities in the United States. A less conservative, but still reasonable, estimate of 10% return to capital was used in the high estimates of transmission costs. The 10% figure is based on recent inflation and "tight money" in financial markets.

3) Operation and Maintenance of the Transmission Line. Annual operation and maintenance expenses were estimated at 1% of investment cost (FPC 1964).

4) Property Taxes. Property taxes will be paid on the value of the transmission line and substations. The estimated property taxes paid are based on the average State of Montana mill levy and original costs of the facilities.

5) Federal Corporate Income Taxes. Federal income taxes, like property taxes, are considered an allowable operating expense when calculating a utility's revenue requirements. In other words, they are passed on to the consumer, and any taxes accrued as part of the transmission project would be considered part of the cost of transmission.

6) Opportunity Cost of Line Losses. Line loss is power that is lost during transmission because of the resistance of the line. The opportunity cost of those losses is their value in alternative uses.

7) Depreciation of Line and Substations. Because the line and substations have an assumed useful life of 37 years, each year's part of the cost of the line and of the substations is charged agains current operations. This is called deprecation expense.

The results of the calculations of the cost to the customers, over the assumed 37 year operating life, of building the 500 KV lines are summarized in Table 4-4. The six transmission estimates are a result of using the three cost estimates shown in Table 4-2 (plus the allowance for interest during construction) with the two rates of return (8% and 10%) shown in point 2 above. Estimates A and B in Table 4-4 use Estimate 1 from Table 4-2 with 8% and 10% rates of return, respectively; C and D use Estimate 2 with 8% and 10% return rates; and E and F use Estimate 3 with 8% and 10% return rates.

In Table 4-3, the estimated annual cost of coal shipment is presented. These figures are based on a rail distance of 554 miles and a rail tariff of $.0095 per ton-mile. The $.0095 per ton-mile is based on estimates furnished by the Burlington Northern Railroad Company (Sandgren 1974) for a Colstrip to Spokane routing. (The applicants' analysis (Westinghouse 1973) used a $.009 per ton-mile figure for Colstrip to Hot Springs, which would reduce coal shipment costs by 5%.)

These figures represent a summation of all the costs referred to above. Taxes, depreciation, fuel, labor, and capital costs are included.

The amount of coal shipped depends upon the average load factor of the units. Since load factor is assumed constant for extended periods of time, coal tonnage shipped, and therefore costs, will also remain constant over that interval. It is for this reason that the years are grouped.

TABLE 4-3

ANNUAL COST OF COAL SHIPMENT

Period (Years)	Average Load Factor	Annual Coal Tonnage	Shipping Cost per Year ($000)
1- 9	80%	5,796,000	30,504.5
10-16	75%	5,433,750	28,597.8
17-23	65%	4,709,250	24,784.8
24-30	55%	3,984,750	20,971.7
31-37	45%	3,260,250	17,158.7

The comparative costs of coal shipment versus the six (A through F) estimates of transmission line costs are shown in Figure 4-1. The total costs over the 37-year life of the facilities are compared in Table 4-4.

TABLE 4-4

COMPARISON OF TOTAL ESTIMATED COSTS TO CUSTOMERS OF TRANSMISSION ESTIMATES TO COAL SHIPMENT ESTIMATE

Estimate	Total 37 Year Costs ($000)	% of Total Costs of Coal Shipment
Transmission A	1,076,963	118
Transmission B	1,160,578	127
Transmission C	1,315,881	144
Transmission D	1,421,164	155
Transmission E	1,020,071	111
Transmission F	1,098,455	120
Coal Shipment	915,132 1/	100

1/ Cost of shipping is computed from Table 4-3.

Based on the estimates used, the cost to the customer of transmitting energy from Colstrip to Hot Springs via two 500 KV lines is much higher than the cost of shipping equivalent amounts of coal to Hot Springs.

4.1.2. Costs to the Applicants

In this section, costs affecting the applicant companies and BPA are considered. Because it owns and operates the transmission lines over which Colstrip energy would flow from Hot Springs west, BPA costs must also be included if any location west of Hot Springs is considered. For purposes of this comparison, an end point in the vicinity of Spokane, Washington, is used. Again, as in the previous section where Hot Springs was selected as the end point, Spokane is not being suggested as the alternative site, but it is put forward as a single point of comparison.

4.1.2.1. The Costs Compared

For purposes of this cost comparison, only the actual direct dollar costs to the companies and to BPA are considered. Unlike the comparison of customer costs, no allowance for return to capital is made. Likewise, federal income taxes are excluded. Included are those costs directly attributable to building Units 3 and 4 in Colstrip, Montana, rather than in Spokane, Washington, such as differences in investment costs and differences in annual operating costs. For simplicity they are kept separate here.

A. Differences in Investment Costs

The biggest single difference in investment costs is in the construction of the transmission lines from Colstrip to Spokane. A distance of 430 lines is assumed from Colstrip to Hot Springs and 165 miles from Hot Springs to Spokane. Between Colstrip and Broadview (110 miles) it is assumed that only one line is needed; from Broadview to Hot Springs two lines are assumed, and from Hot Springs to Spokane only a single line is assumed.

Two different line construction cost estimates are used. The first parallels estimate 2 in Table 4-2 for the 750 line miles from Colstrip to Hot Springs ($250,000/mile); unadjusted BPA figures (Wilkerson 1974) of $266,500/mile are used for the 165 miles from Hot Springs to Spokane. Total line costs resulting are $231,472,500. This amount will be used in the first estimate.

The second line cost estimate is based on estimate 3 (Table 4-2) figures for the 750 miles of line to be built by the applicants ($175,000 /mile) plus $266,500/mile for the BPA segment from Hot Springs to Spokane. The resulting total line construction cost is $175,222,500. This figure will be used in the second estimate.

Both estimates of line construction costs assume a single line is needed from Colstrip to Broadview; this in reality understates the cost by assuming one line is already built from Colstrip to Broadview./1

A second capital investment is the substation equipment associated with the 500 KV lines. An estimate of $35,073,000 (Westinghouse 1973) is used here.

A third capital expenditure necessitated by a Colstrip siting of Units 3 and 4 is the 30 miles of water supply line from Nichols to Colstrip, and the associated pumping facility. This investment is estimated at $14,764,500 (Evans 1974).

The fourth and last capital expenditure necessitated by the Colstrip site is the additional generating capacity utilized just to cover line losses. If the units were built in Spokane, they could be built appreciably smaller and still yield the same potential peak output. A peak line loss figure of 5% is used and applied to the total estimated installed costs of Units 3 and 4 (Westinghouse 1973). This yields a capital cost of capacity of $17,850,000.

An additional capacity loss charge might be made to cover the pumping energy used to get cooling water from Nichols to Colstrip. However, as long as there is sufficient reserve in the surge pond, pumping could be scheduled at off peak hours, and output capability would not be affected.

B. Differences in Operating Costs

Although property taxes are a function of the line itself, they are included here because their expense accrues annually. Based on the method described previously, annual property taxes are estimated to be $7,478,500 and $5,588,400 on the respective estimates of the combined substation and transmission line investment. No property tax is charged against the BPA-owned lines. No adjustment for property taxes on differences in generating plant capacity necessitated by line losses or for property taxes on the water supply line is included.

A second annual cost is operating and maintenance expenses. Estimates range from .5% to 1% of the original investment. The lower figure of .5% is applied here to both the line and the substation investment.

A third annual expense considered in this analysis is the expense of energy lost in transmission or line losses. The reduction in delivered capacity due to line losses has been considered above as an investment cost; here we are concerned only in the incremental cost of those losses. The figure used in the present analysis will be .3 cents per kw-hr. This is the approximate fuel cost per kw-hr expected for Units 3 and 4. Losses in kw-hr's are estimated at 5% of the average load.

The final expense item considered is the energy cost of pumping water from the Yellowstone River at Nichols to Colstrip, a distance of about 30 miles with a rise of approximately 750 feet in elevation. The MPC estimate of $410,404 (Evans 1974) utilized a 1.71¢ per kw-hr cost. This analysis will use a .3¢ per kw-hr estimate of costs to yield pumping costs of $72,000 per year assuming an 80% load factor.

C. Differences in Timing of Costs

One very great difference between the costs of shipping coal and the costs of construction of transmission lines is the timing of expenditures. If the transmission lines are built, construction is assumed to begin on one line in mid-1975 and be completed in mid-1978. Construction on the second line is assumed to start in mid-1976 and be completed in mid-1979. Costs associated with their operation are likewise assumed to begin in mid-1978 and mid-1979. For the coal shipment alternative, the timing of shipments is the same as the in-service dates for the lines: half-scale shipping from mid-1978 to mid-1979, and full-scale shipping after mid-1979. For both the building and the shipping alternative, the load factors are assumed to be the same as those in Table 4-1. Amount of coal shipped, line losses, and pumping costs will vary with load factor.

The technique used to put all of these costs occurring in different time periods on a common basis is to discount payments in the future more heavily than current payments. A payment to be made t years from now is divided by $(1 + r)^t$, where r is called the discount rate. As an example, with a discount rate of 10%, an expenditure of $100 five years hence is divided by $(1.10)^5$, or 1.61051, and the resultant value of $62.09 is referred to as the discounted present cost of that future expenditure. For the comparison of the two alternatives being considered, the discounted present values of each will be the basis of comparison. For each alternative, each of the previously determined expenditures will be discounted to the year 1975, and the total discounted value of future expenses for the transmission line estimates will be compared to the total discounted value of the future coal transport expenses. The rate of discount used throughout will be 10% per year. This, at the moment, is an extremely conservative figure, and would not cover even current inflationary changes from one year to the next.

The calculation of the present value of estimated costs is presented in Volume 2, Chapter 4. That analysis shows shipping costs to fall between the two estimates of transmission costs. In terms of cost to the company, the alternatives are quite close. They are summarized here.

Estimate	Discounted Costs (in $000)	Compared to Coal Shipments (in $000)
1st Estimate	$323,448.1	+$31,900.8
2nd Estimate	$260,843.4	-$30,703.9
Coal Shipment	$291,547.3	

If these costs are spread over the life of the lines, they amount to less than $1,000,000 per year.

4.1.3. Cost Comparison Made by the Applicants

In the analysis done for the applicant companies (Westinghouse 1973), coal transport costs were compared to transmission costs from Colstrip to Hot Springs. The conclusion of that analysis was that coal shipment would cost approximately $10,000,000 per year more than transmission costs.

4.1.3.1. Reconstruction of the Applicants' Comparative Cost Analysis

In order to reconcile the difference between the applicants' figure and those derived in the Department's analysis, an attempt was made to reconstruct the applicants' analysis.

There appear to be three errors in the applicants' analysis that account for much of the difference. The first is merely a mechanical error, which results from using the wrong inflationary index number. The basis of the applicants' transmission cost estimate was published in The 1964 National Power Survey (FPC 1964), but the figures were from 1962 data. Their analysis used the data as if it applied to 1964.

The second, and most significant error, is that the data source used for estimating transmission line costs is for a single line, with no provision for a second, back-up line. This data would be applicable to a single line from Colstrip to Hot Springs, but not for the costs associated with the proposed double lines. For two lines, the estimated costs should be nearly 50% higher, if this data source is to be used at all.

The third problem area is that, in the applicants' analysis, coal shipment costs were calculated at an 80% load factor for the generating units. Although this may occur in the early years of operation of the units, 80% represents a much higher load factor than can be expected over the life of the units. In an excerpt used previously in this chapter (FPC 1968), it is estimated that a load factor of 55% to 60% is typical. Using this estimate, average annual coal shipments over the life of the units would be only about 3/4 of the amount used in the applicants' analysis.

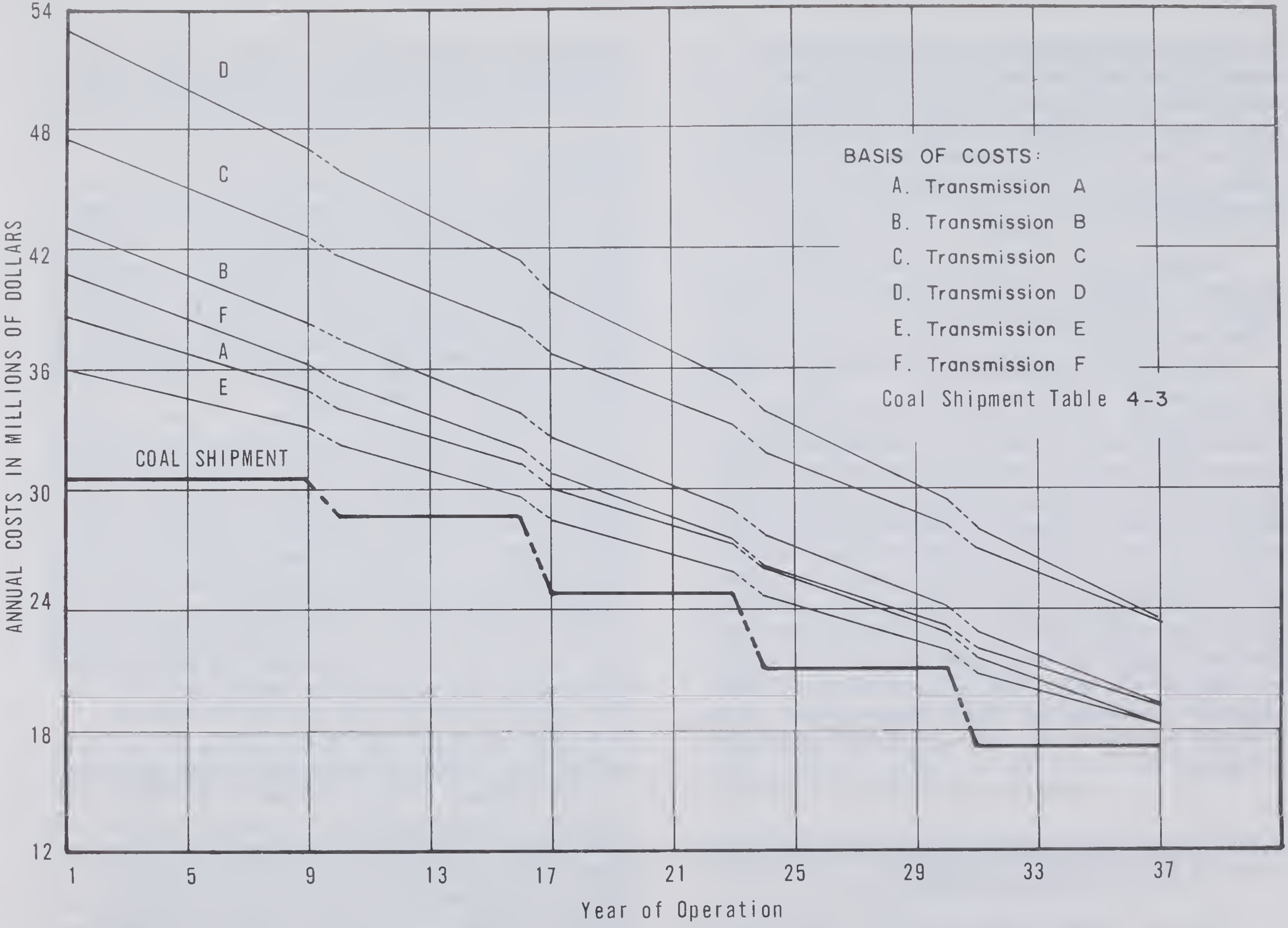
The first two errors mentioned above (inflation index and inclusion of the second transmission line) have been corrected, and the whole comparison was updated to 1974 (the applicants' analysis was as of 1972). The result showed the coal shipment costs to be about the same as the transmission costs; both were approximately $30,500,000 per year. If the average load factor over the life of the units was considered, coal shipment costs would drop to 3/4 of this figure, or about $23,000,000. Transmission costs could also be expected to drop, but only slightly since the only costs that would vary with use would be the line losses.

4.1.4. Comparative Cost Conclusions

For the three cost comparisons made, the option of shipping coal from Colstrip to either hypothesized location ranges from much cheaper to slightly more expensive than the applicants' proposed option. These comparisons do not include all costs that might be imputed to either course of action, though the major items have been considered.

The first calculation (Section 4.1.1.) attempted to evaluate the two alternatives in terms of costs to the ultimate consumer of electricity. This is conceptually the best approach. Rail tariffs charged should include taxes and returns to stockholders as well as labor, fuel, and equipment expenditures. Costs of transmission lines likewise should include taxes and a rate of return to the stockholder; they are both real costs of business. Three different estimated transmission capital investment expenditures were used in combination with two different rates of return to stockholders. In each of the resulting six cases, coal shipment provided a substantially cheaper alternative (see Figure 4-1).

The second comparison (Section 4.1.2.), was a comparison of costs to the producer. Expenditures were spread out over the next 40 years in an estimated chronologic sequence. All expenditures were then discounted backward to the year 1975 and totaled for each alternative. Regardless of the fact that no return to the applicants' stockholders was included, coal shipment compared favorably to transmission.



Comparison of Costs to Electric Customers:
Coal Shipment Versus Six Estimates of Transmission Costs

FIGURE 4-1

The third calculation (Section 4.1.3.), attempted to retrace the calculations made by the applicants (Westinghouse 1973). After correcting what appears to have been mistakes in interpretation made in that analysis, coal shipment became slightly cheaper than electric energy transmission.

Beyond these dollar cost figures, there is another advantage to coal shipment; that advantage is reliability.

One strong disadvantage of electric energy as compared to fossil fuels is that it is difficult to store electric energy. Production must follow the fluctuations of demand through time. Coal can be and is stored at power plants for lengthy periods of time. For example, there will be a 90-day supply of coal stockpiled at the generating site in Colstrip. The same would be true if built at any other site. This means that the rail shipment could be disrupted between the mine and the generating plant for up to 90 days without affecting the capability of the station to supply the load. As compared to this, simultaneous breakdown of both transmission lines (landslides, etc.) would mean instantaneous loss of load.

4.2. Beyond Comparison of Costs: The Possibility of Coal Shipment and Impacts

In the above sections, cost comparisons showed coal shipment to be an economically viable alternative when compared with transmission lines. This section takes a more detailed look at additional aspects of coal shipment. A destination in the Spokane area is assumed as an example.

The Colstrip proposal projects the delivery of 1,390 megawatts of peak power to west coast utilities. As an alternative, the equivalent energy in coal could be delivered via existing Burlington Northern tracks. The rail shipment of coal would also export many of the environmental side effects stemming from the generation and transmission of electricity.

It is estimated that a maximum of 5,800,000 tons of coal would have to be shipped annually to generate the amount of power equivalent to that produced by Units 3 and 4 at the load center. Coal shipments of this magnitude, over a long period of time, would take place on unit trains--trains that carries "one commodity from origin to destination in a continuous cycle, slowing down for loading and unloading and stopping only for fueling and inspection" (Welty 1973, p. 22).

Unit trains are a relatively recent innovation in railroad technology. Prior to passage of the National Transportation Act in 1958, rail tariffs on large multi-car shipments of coal and other goods could not be less than 85% of single-car rates. Since that time the economies of scale which result from unit train shipments have allowed railroads to reduce freight rates considerably on unit train routes. These economies stem largely from efficient utilization of equipment, almost no need for switching, and the routinization of scheduling, maintenance, and inspection.

Unit trains typically require heavy duty power units and use large-capacity freight cars. Because of this, the capital costs for unit train equipment are larger than for ordinary rolling stock. In return, the equipment has a more productive lifetime than other equipment. For example, the power units required for unit train use are 3600 H.P. special duty diesels costing $435,000 each, compared to the 3000 H.P. ordinary diesels costing $350,000 each./2 Coal cars are larger, too: a new unit train operated by the Black Mesa and Lake Powell Railroad is equipped with 122-ton hoppers rather than the more usual 100-ton cars. The cars are designed with electrically operated bottom-dump doors which allow completely automatic unloading of each car in less than 15 seconds. The special design means the hoppers cost $40,000 each (O'Connell 1974). Thus, unit trains are larger and more automated than mixed trains.

Because of intense use and heavy loads, unit trains and track surfaces subject to unit train use require more maintenance than is customary. The Burlington Northern reported in 1973 that:

> ...track surfaces deteriorate under the heavy loading, necessitating more frequent surface correction. Superelevation on curves must be maintained at the equilibrium elevation for the actual train-speeds achieved. Rail anchors must be maintained and patterns increased to resist rail creepage. Joints must be kept tight and properly supported to prevent advance of rail defects within the joint area. Subgrade defects, such as slides and sinkholes, must be treated and eliminated because heavy unit trains activate and magnify these difficulties (Welty 1973, p.26).

To cope with these problems, as well as accelerated wear on couplers, wheels, and other parts, regular scheduled maintenance is necessary.

Burlington Northern (Davies 1974) has furnished information on the type and frequency of trains required to ship Colstrip coal west to utilities in Washington (vicinity of Spokane), based on six million tons per year. The maximum grade on the westbound route is 2.2%. As a result, a train with six diesel-powered units is limited to a total weight of 7,200 tons by American Association of Railroads regulations. Fully loaded, this would mean a 55-car train with 129-ton hoppers. To move six million tons per year would require 1091 trainloads, each with a five-day turnaround time. These figures translate into three trains a day or fifteen trains of equipment in constant operation.

If all of the equipment for this operation were newly purchased, it would involve a minimum capital outlay of $72 million:

6 engines/train x 15 trains = 90 engines	
@$435,000 each	$39,150,000
55 cars/train x 15 trains = 825 cars	
@$ 40,000 each	$33,000,000
TOTAL	$72,150,000

By utilizing existing equipment, Burlington Northern estimates a total capital outlay of $36 million would be necessary. The diesel equipment has an expected life of 20 years (Gustafson 1974); after that period the engines may be rebuilt for about one-third of the original capital cost (Tomco 1974). The hoppers also have an expected life of 20 years, although they are generally depreciated over a 14-year period (O'Connell 1974).

Delivery dates vary: the Ford Motor Corporation reports an 18-month waiting period for new hoppers with delivery following at a rate of one car per day. General Motors estimates a 15-month delivery date for special-duty diesel engines. Both firms feel they can handle orders of the above magnitude in these periods. Thus, the rolling stock could be available for large-scale movement of coal by mid-1977.

The unit train movement would represent a comparatively large new demand for diesel fuel. Each train would require 24,000 gallons per round trip. For 1091 trips per year, about 26.2 million gallons of diesel fuel would be required.

The additional employment associated with 15 trains of equipment was estimated by Burlington Northern as shown in Table 4-5.

TABLE 4-5

ADDITIONAL BURLINGTON NORTHERN EMPLOYMENT REQUIRED FOR UNIT TRAIN OPERATIONS

Job Description	Number of Employees	Annual Salary	Annual Wage Bill
Maintenance of Way	34	$12,000	$ 408,000
Car Department	60	12,000	720,000
Locomotive Department	65	12,000	780,000
Operating & Clerical	6	12,000	72,000
Enginemen	33	22,000	726,000
Trainmen	99	17,000	1,683,000
Vacation Relief and Contingencies	45	15,000	675,000
Total Employment	342		$5,064,000

Not all of these employees would reside in Montana. If it is assumed that the residence of employees is proportional to the number of track miles in each state, then about 28% of these employees would reside outside Montana--an estimate which is probably on the high side. Seventy-two percent of the 342 employees, or 246 persons, would be residents of Montana.

In addition to income taxes paid to the state by these employees, Burlington Northern would pay state property taxes on the general system improvement resulting from the capital outlay used for the unit train rolling stock, and federal and state taxes on the additional profit resulting from the unit train operations.

The estimate of 246 in-state, long-term jobs compares very favorably with the prediction of 95 generating station jobs created by the operation of Units 3 and 4. These numbers represent primary jobs and would create additional secondary employment. The employment that would be lost to the state would be the four years of construction jobs necessary to build Units 3 and 4 and the transmission lines, and the related secondary employment associated with the construction.

This assumes that the units would be built in the Spokane area, and of course there is no guarantee that will occur. It is an alternative location if the power from Units 3 and 4 is needed in the Northwest.

If comparable units were not built in the Northwest, then impacts are less certain. Given the impetus to mine western coal and the bouyant present market for coal, the coal will be mined. If shipped east, the employment impacts of shipping on Montana labor would not be as great as westbound shipments; however, the number of jobs created might approach the 95 jobs created to operate Units 3 and 4.

FOOTNOTES
CHAPTER FOUR

1. To be correct, the difference between double wood pole 230 KV lines and a 500 KV line from Colstrip to Broadview should be added to the cost.

2. Prices are for General Motors SD 45-2, $435,000; GP 40-2, $350,000 (Gustafson 1974).

CHAPTER FIVE Alternative Plant Technologies

The alternative power plant technologies which require consideration are the various heat rejection or cooling systems and the various emission control systems.

5.1. Alternative Cooling Systems

A heat rejection or cooling system is necessary for steam power plant operation whether nuclear fuel or coal is being used. The overall effect of a good cooling system is to improve the units' operating efficiency.

5.1.1. Comparative Descriptions

Eight alternative cooling systems were studied, but no attempt will be made to recommend any one system at this time.

5.1.1.1. Once Through Cooling

Once through cooling is the most common method for removal of heat from power plant condensers in the United States. In this system, cool water is drawn from a natural source and circulated through the power station condenser tubes, where it picks up the latent heat of the steam condensing on the outer surface of the tubes. The warmed water is then discharged to the river at a point where recirculation of the warm water will not occur. No attempt at cooling the warm water prior to discharge is made, in contrast to other cooling techniques.

5.1.1.2. Cooling Ponds

A cooling pond is one alternative for heat dissipation in a closed-loop process. In this system, heated water from the condenser is discharged into one side of a natural lake or pond or one specifically created for power plant cooling. Here, it usually mixes to some extent with the receiving water and drops in temperature. The mixed water then proceeds through the pond, transferring heat from the pond's surface to the atmosphere by evaporation, convection, and radiation. Cooling capacity must be sufficient to insure satisfactory condenser intake temperatures.

5.1.1.3. Spray Ponds

Spray ponds operate on the same principle as cooling ponds. However, the evaporation resulting from exposure to the air is enhanced by spraying the warm water into the air over the pond.

Residence time in the air is thus increased, as is the relative velocity between the water droplets and the air. The spray nozzles are usually 5 to 10 feet above the surface of the pond.

5.1.1.4. Natural Draft Evaporative Cooling Tower

An evaporative or wet cooling tower is a device which cools water by bringing into contact with air. The water and air flows are directed in such a way as to provide maximum heat transfer. The heat is transferred to the air primarily by evaporation, while the remainder is accomplished by sensible heating.

Several factors, other than enthalpy and temperature differences, affect the rate of heat transfer. First, the interfacial area between the water and air is an important parameter. Packing is commonly used to break the water up into smaller droplets which evaporate more easily (splash type packing) or provide more surface area upon which to develop liquid films (film type packing). A second important parameter is the relative velocity between the air and the water. Higher velocities allow more heat to be carried away in a given amount of time. Finally, the residence time of the air in the heat transfer section of the tower is important. Sufficient packing height must be provided so that the air leaving the tower will be saturated.

A natural draft cooling tower is designed so that the movement of air through these towers is a natural draft due to a difference in density between the inlet and exit air streams. That is, the air outside the tower has a slightly greater density (on the order of 0.05 lb/ft^3) than the air inside the tower above the packing. The difference in hydrostatic pressure between two columns of air of equal height, one inside the tower and the other outside, drives the air through the packing and up the tower. The driving potential is directly proportional to the density difference and the height of the columns. Air drawn through the tower contacts the condenser water, which is continually redistributed into fine droplets while falling through the tower packing to provide a large air-water surface contacting area. Heat is transferred from the water to the air by convective transport of sensible heat and by evaporation. All heat transfer occurs as a result of direct contact between the naturally drafted air and the recirculating condenser cooling water.

5.1.1.5. Mechanical Draft Evaporative Cooling Towers

As in the natural draft tower, cooling in the mechanical draft tower (Figure 5-1) is achieved by bringing water into direct contact with air flowing through the tower.Heat is transferred to the air primarily by evaporation,

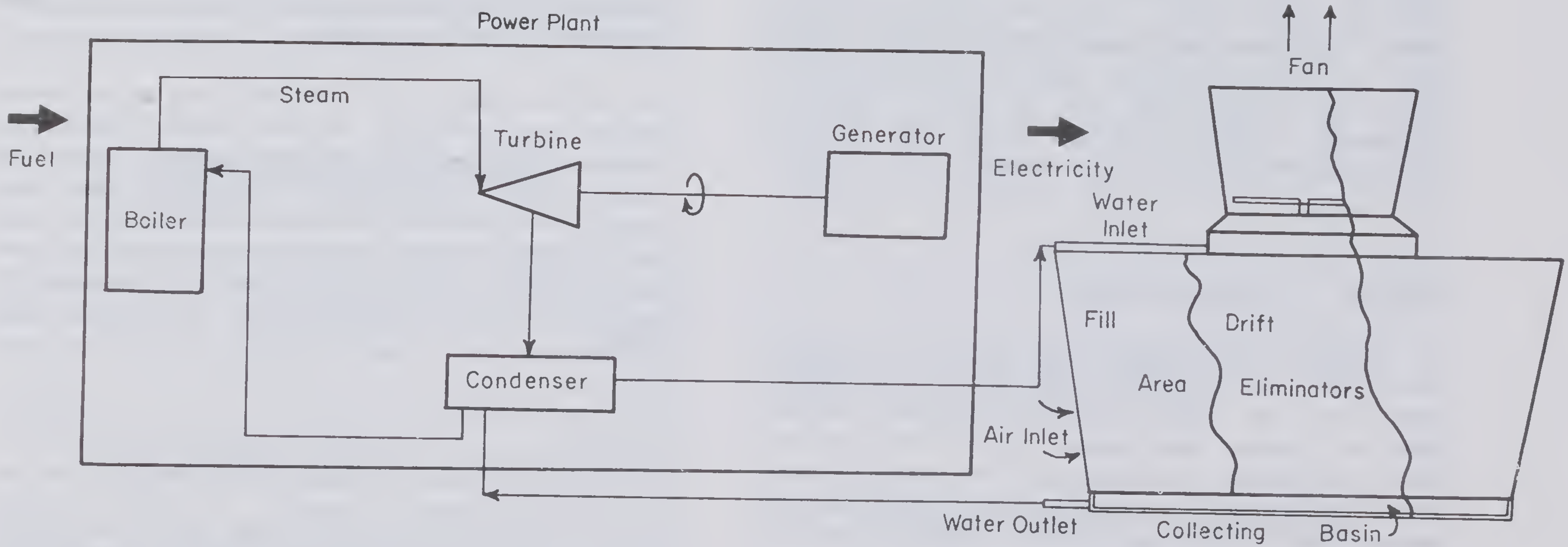


FIGURE 5-1 MECHANICAL DRAFT EVAPORATIVE COOLING TOWER

although some sensible heating of the air is also involved. The air flow in a mechancial draft tower is produced by a fan which may be placed at either the inlet (forced draft) or the exit (induced draft) of the tower. The air flow rate can thus be controlled to satisfy off-design cooling requirements. The use of the fan also means that the great height of the natural draft unit is not necessary. Large mechanical draft units are usually 60 to 80 feet tall. The mechanical draft cooling tower can thus be built in a realtively compact and standardized manner.

5.1.1.6. Dry Cooling Towers

Though air cooling has been used for many years in the petroleum industry and in automobiles, it was only with the relatively recent work of Heller and Fargo (1956, 1962) that the theory advanced sufficiently to permit larger scale application to central station electrical generation. Dry cooling towers dissipate heat by conduction and convection. Two types of systems have been employed.

In the indirect dry cooling tower, heated cooling water from the plant's condensers is pumped through banks of finned tube heat exchanger surfacers. The heat in the water is transferred by conduction to the metal walls of the tubing, then by convection to air which flows up through the cooling tower, past the tubing, and out of the tower. Since the water and air do not come into direct contact, water is not lost by evaporation. Because the heat transfer does not include the latent heat of evaporation, dry cooling towers require both greater air flows and larger air temperature increases in order to dissipate the same amount of heat as a comparable evaporative cooling system.

The second type of dry cooling is termed direct dry cooling. In this scheme the turbine exhaust steam is condensed directly in the air cooled heat exchangers. Extremely large steam headers are required, and the cooling towers must be located immediately adjacent to the low pressure turbine stages. This tends to restrict the use of direct dry cooling for very large power plants.

5.1.1.7. Hybrid or Wet-Dry Cooling Towers

For plant sites which have some water available but not a sufficient amount for totally wet cooling, a hybrid wet-dry cooling tower is a possible alternative. By varying the balance of wet and dry cooling, a wide spectrum of design and performance characteristics can be achieved. On one hand, the system can be basically a wet cooling tower with supplemental dry cooling to reduce or eliminate pluming and fogging. On the other hand, water consumption can be reduced by operating it as a dry tower with supplemental evaporative or wet cooling. This makes the system operable when dry cooling alone would result in excessive condenser back pressures. Although air flow through the tower may be induced by fans or natural draft, only the mechanical draft system is considered here, since local atmospheric conditions are not favorable to controlled natural draft performance.

5.1.1.8. Combined Dry Tower-Cooling Pond System

An additional power plant heat rejection system which has been proposed is a dry cooling tower operated in conjunction with a cooling pond. This could possibly enable the use of a dry cooling tower within the size range of existing technology, and could also eliminate the summer capacity reduction problems. As in the hybrid wet-dry system, a combined dry tower-cooling pond system could be arranged to reject heat to the ambient air when the process stream is at a high temperature. When the process stream approaches the ambient dry bulb, the stream could be switched to an evaporatively cooled section to take advantage of the greater driving potential provided by the ambient wet bult. Proper proportional of the thermal duty between the dry and the evaporative sections can result in a combined system which provides heat rejection more economically than either an all-dry or an all-evaporative system separately.

5.1.2. Comparative Costs

An economic comparison of the various alternative heat rejection systems is presented in Table 5-1. The once through system has been omitted because it is by far the least expensive system discussed and it does not cool the water after it is used as all the other systems do. The combined dry tower-cooling pond system was also omitted because of unavailability of cost information. The costs for the remaining six systems have been examined and are felt to represent reasonable relative values for the annual costs of the various systems. It may be observed from this table that the annual cost of the natural draft evaporative cooling system is substantially less than any of the other alternatives with the mechanical draft evaporative cooling system running a not too distant second.

5.2. Alternative Emission Control Systems

Due to the tremendous amounts of coal which are burned in the large fossil fuel plants, the potential for atmospheric pollution is likewise tremendous. Therefore, to prevent degradation of the atmosphere and to comply with various state and federal regulations emission control systems must be installed and used.

TABLE 5-1

Estimated Annual Cost of Cooling System Alternatives For Proposed Colstrip Units 3 and 4.

COOLING SYSTEM ALTERNATIVE	TOTAL ANNUALIZED COST
Cooling Pond	$9,518,000.
Spray Pond	$9,562,000.
Natural Draft Evaporative Cooling Tower	$930,000.
Mechanical Draft Evaporative Cooling Tower	$1,566,200.
Dry Cooling Tower	$16,935,400.
Hybrid Wet-Dry Cooling Tower	$10,242,600.

5.2.1. Comparative Descriptions

5.2.1.1. Hot Electrostatic Precipitators

Electrostatic precipitators apply high voltage charges to suspended particles in the gas stream, collect these particles on plates and remove the precipitated material to external receptacles or hoppers. The gas stream is not deflected or disturbed as much as in mechanical collectors, and this results in a low draft loss of the electrostatic device. This type of units is effective on a wide range of paritcle sizes and can achieve collection efficiencies well above 90%. However, the unit is relatively expensive. Also, it relies on the sulfur content of the coal to provide sufficient conductivity of the combustion gases to charge the suspended particles. This system does not work as efficiently on low sulfur coal and has no provision for removing SO_2.

5.2.1.2. Wet Electrostatic Precipitators

Although the previous alternative provides for effective particulate removal, SO_2 would not be removed from the combustion gas. A wet electrostatic precipitator would remove both SO_2 and particulates.

Sulfur dioxide removal is effected as the SO_2 combines with the slurry. These slurry droplets, together with the particulates, adhere to the charged plates and are washed by a continuous spraying action into a hopper located beneath the plates.

5.2.1.3. Bag Filters

This industrial gas cleaning process uses fibers in woven or felted fabrics in the form of tubular or flat filters. A filter cake is generally formed, which itself acts as the filter medium. After a specified pressure loss occurs in the fiber filter, the filter cake is removed by a suitable technique. The filtration process is then recommended and repeated periodically. These types of filters, known as bag filters, would provide the highest particulate removal efficiency, greater than 99.5%, of all alternatives. Although they cannot be used continously above 500°F, the temperature of the combustion gas after it passes through the preheaters should be considerably below this value.

5.2.1.4. Centrifugal Separators

Most centrifugal separators depend upon the centrifugal effect of many small radius turns in the stream of dust laden gas and on the cyclone effect. Some incorporate multiple vertical tubes where both effects are utilized. Others use large cyclones with recirculation fans and ducts. Efficiency is closely related to particle size, and increased efficiency can usually be obtained only at the expense of increased draft loss.

5.2.1.5. Boiler Injection Sulfur Removal Systems

Several systems for reducing SO_2 levels by injecting various forms of lime, limestone or dolemite directly into the boiler are being developed. The lime or limestone which is added reacts with the SO_2 in the combustion gases and removes it from the gas flow. The reaction converts the SO_2 to a solid form which then must be removed from the boiler. This system does not remove particulates.

5.2.1.6. Sulfur Recovery Systems

Sulfur recovery systems are systems which chemically treat the combustion gases from the boiler and remove the SO_2 Several companies have been developing systems which would not only remove sulfur from the flue gas, but would yield a saleable sulfur product. These systems are considerably more expensive that the conventional systems and have not yet been as reliable. These systems would not remove particulates from the gases.

5.2.1.7. Wet Alkali Scrubbers

The proposed system is a wet alkali scrubber which would remove fly ash and reduce SO_2 by scrubbing the total flue gas in a single stage venturi scrubber. A slurry of fly ash with a high level of available alkali, supplemental by a soda ash solution, is used for the scrubbing. Figure 5-2 shows a schematic diagram of the proposed scrubber.

Each scrubber train would consist of a venturi scrubber, reheater, induced draft, fan and associated ductwork and piping. Each would provide two contacts between liquid and gas streams for removal of both fly ash and SO_2. The first contact occurs in the venturi throat section and is of cocurrent flow type. The second contact occurs in the separator section and is of the counter-current flow type. Basically, all of the fly ash removal and partial SO_2 removal is accomplished in the throat section. The counter-current spray sections optimize SO_2 removal. The bleed from the trains is combined and pumped to the ash pond.

5.2.2. Comparative Summary

All of the emission control systems, which were discussed, are summarized in Table 5-2.

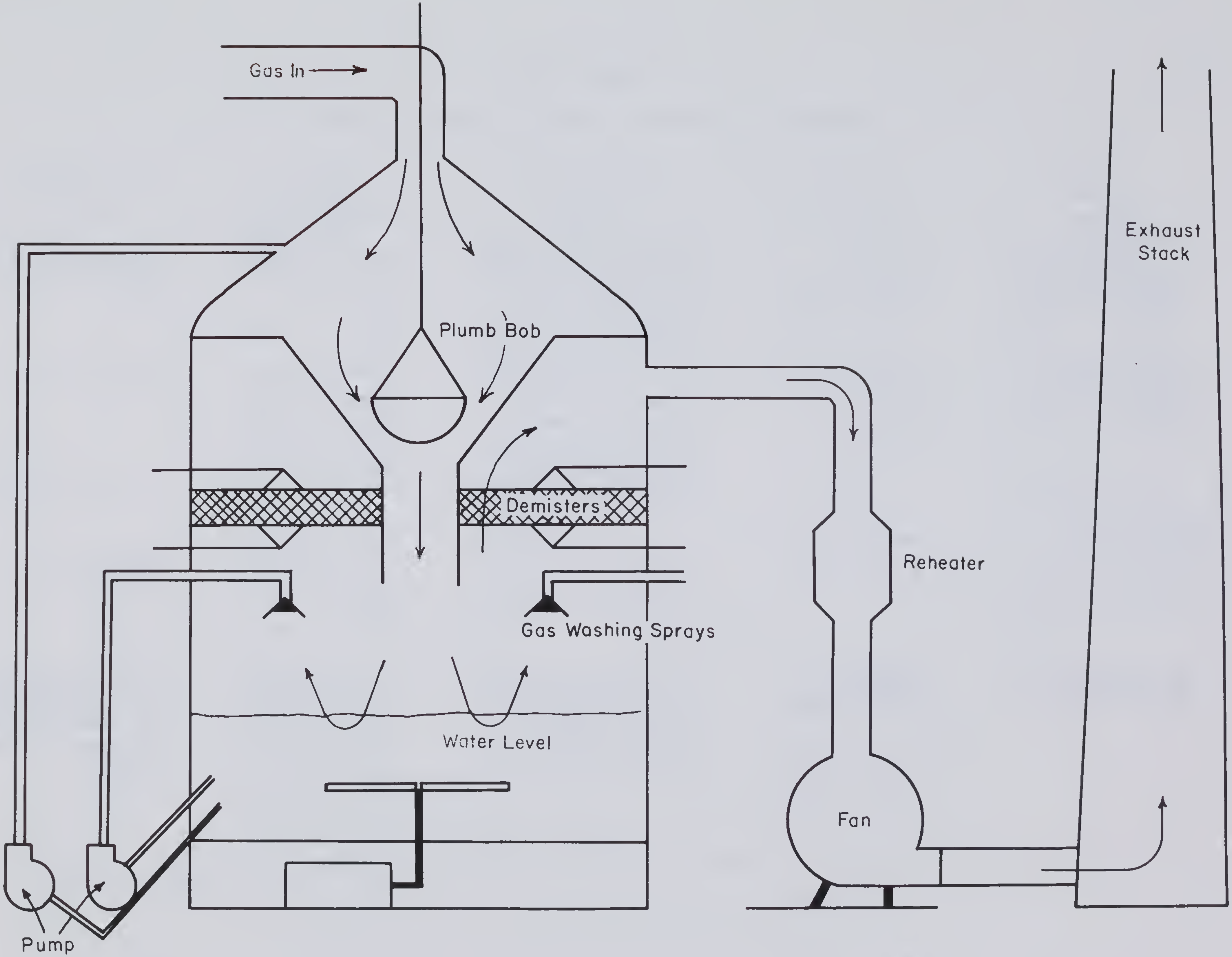


FIGURE 5-2 **WET ALKALI SCRUBBER**

TABLE 5-2

SUMMARY OF ALTERNATIVE EMISSION CONTROL SYSTEMS

Removal System	Function	Technique and Process	Removal Efficiencies	Installation Cost
Hot Electrostatic Precipitators	Remove particulates	Electrically charge the particulates and collect on plates.	Particulates approximately 99% SO_2 - None	Approximately $25 to $35 /kw.
Wet Electrostatic Precipitators	Remove particulates and SO_2	Mix the combustion gases in a slurry which is electrically charged and the particulates collected on plates.	Particulates approximately 99+% - SO_2 approximately 80%	Not available
Bag Filters	Remove particulates	Mechanically filter the particulates from the combustion gases.	Particulates approximately 99+% SO_2 - None	Approximately $25 /kw.
Centrifugal Separators	Remove particulates	Use the centrifugal effect of small radius turns to throw out the particulates.	Particulates approximately 95% (95% for particles over 40 microns. Most Colstrip particles will be less than 5 micron) SO_2 - None	Cost is quite small, compared to other systems. Not used on Power Plants.

TABLE 5-2 (cont.)

Removal System	Function	Technique and Process	Removal Efficiencies	Installation Cost
Boiler Injection Sulfur Removal Systems	Reduce SO_2 levels	Inject some material into the boiler gas stream to combine with the oxides and convert them to a removable liquid or solid.	Particulates None SO_2 - Low (A high efficiency would be difficult to obtain)	Not available at this time. Some particulate removal system, such as precipitators, is also required, necessitating addition costs.
Sulfur Recovery Systems	Remove sulfur from flue gases and provide a saleable sulfur product.	Several different techniques and processes are being developed.	Particulates None SO_2 - Not available	Considerably more expensive than conventional systems. It is also necessary to have a particulate removal system, requiring additional costs.
Wet Alkali Scrubbers	Remove particulates and SO_2	Provide contact between liquid and gas streams for removal or particulates and SO_2.	Particulates approximately 99+% SO_2 - Variable (Possibly as high as 80% removal SO_2)	Approximately \$40 to \$60 /kw.

Note: Trace elements are treated or considered separately. No present systems are designed for trace element removal.

CHAPTER SIX Colstrip Power Plant Complex

6.1. Summary of Colstrip Project

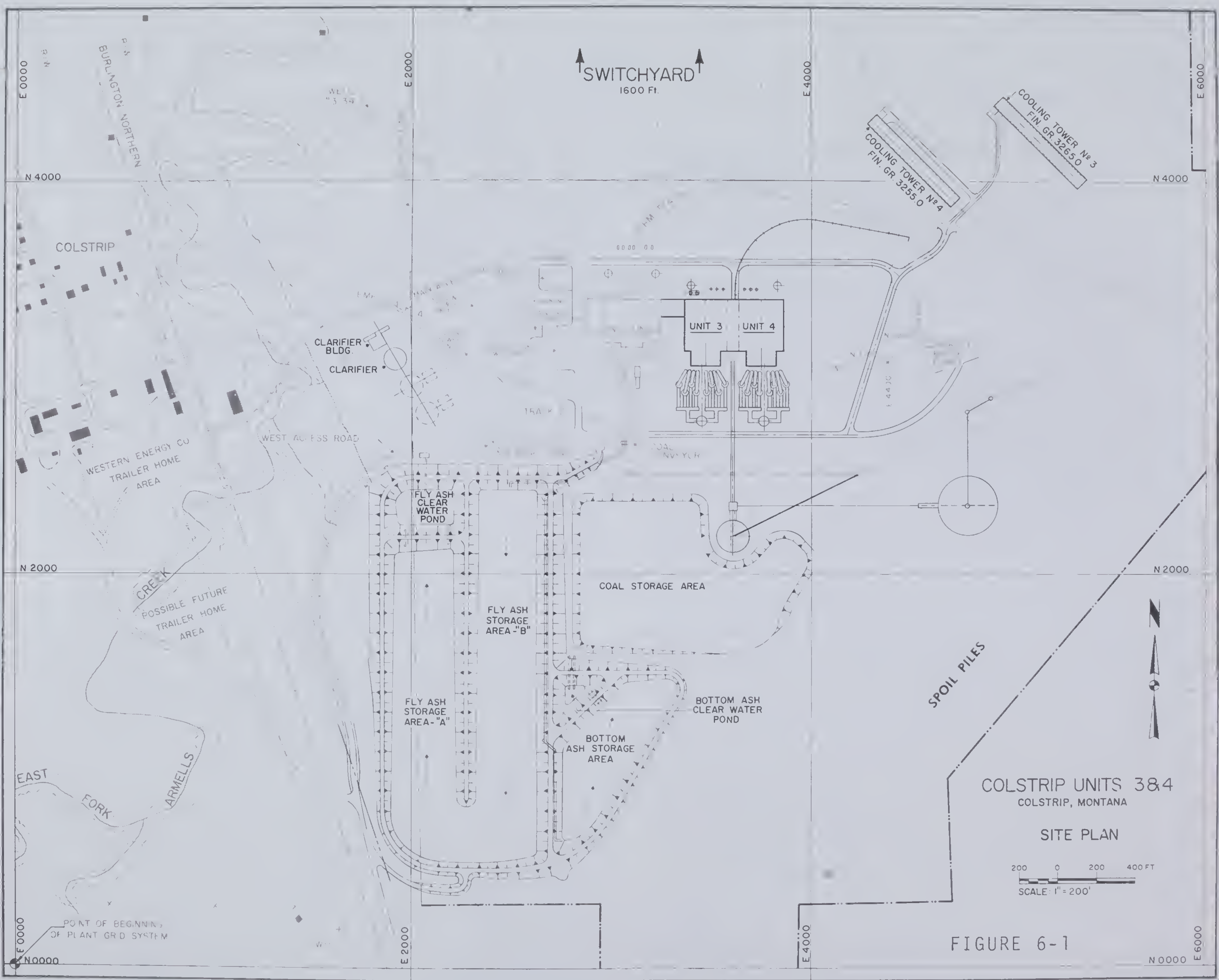
The Colstrip project, as proposed by the applicants, would initially utilize some 700 acres of land exclusive of the transmission lines. The surge pond for emergency water storage, which is under construction with Units 1 and 2, will cover approximately 150 acres, and the ash pond will cover approximately 350 acres. The remaining 200 acres will house the actual generating units, the switchyard (69 acres), the coal storage area (23 acres), the cooling towers, the on-site ash ponds, and other associated components and buildings for the power plant complex (See Figure 6-1 for a plan of the power plant site). The ash pond as proposed is sufficient for only 20 years' ash disposal, and at some time in the future another ash pond site must be designated since the life of the plants is expected to be 37 years.

Water required by the plants, which primarily consists of make-up water to replace water evaporated by the cooling towers, would be pumped from the Yellowstone River some 30 miles away. Two pipelines, one 26 inches in diameter and the other 36 inches in diameter, were proposed to transport the water pumped by three, 4,000 horsepower motor driven pumps. The water would either be routed to the surge pond for storage or bypass the surge pond to go directly to the units as proposed, each unit has a separate cooling tower and cooling water supply system. The make-up water for all of these systems would be about 50 cfs of the total 59 cfs maximum water flow into the plant.

The cooling water enters the condenser, where it picks up heat from the low pressure steam which is being condensed. Upon leaving the condenser, the hot cooling water is pumped to the cooling towers, where it is cooled by partial evaporation. The cooled water leaving the towers is then ready to mix with the make-up water and go back through the condenser.

Part of the water which does not go to the cooling system is used for boiler make-up water. This water is highly demineralized and becomes part of the closed boiler system. The water is heated by the flame in the boiler to produce steam of 1,000+F and 2,400 pounds per square inch (psi). This steam is piped to the turbine where it is expanded, rotating the generator shaft and producing electricity. After the steam is expanded through the last stage of the low pressure turbine, it is passed down into the condensor, where it is condensed by the cooling water. The condensate is then routed through a series of heaters and finally returns to the boiler for further heating and conversion back into steam.

The coal, which is mined in nearby strip mines and delivered to the site by truck, is dumped in the unloading area in large chunks. This coal is conveyed by belt to the crusher,



SWITCHYARD
1600 Ft.
COOLING TOWER Nº 3
FIN. GR 3265.0
COOLING TOWER Nº 4
FIN. GR 3255.0
BURLINGTON NORTHERN
COLSTRIP
CLARIFIER BLDG.
CLARIFIER
UNIT 3
UNIT 4
WEST ACCESS ROAD
WESTERN ENERGY CO
TRAILER HOME
AREA
FLY ASH
CLEAR
WATER
POND
FLY ASH
STORAGE
AREA-"B"
FLY ASH
STORAGE
AREA-"A"
COAL STORAGE AREA
BOTTOM ASH
CLEAR WATER
POND
BOTTOM
ASH STORAGE
AREA
SPOIL PILES
CREEK
POSSIBLE FUTURE
TRAILER HOME
AREA
EAST
FORK
ARMELLS
POINT OF BEGINNING
OF PLANT GRID SYSTEM
N
N 4000
N 2000
N0000
E 0000
E 2000
E 4000
E 6000
COLSTRIP UNITS 3&4
COLSTRIP, MONTANA
SITE PLAN
200
0
200
400 FT
SCALE: 1" = 200'

FIGURE 6-1

where it is crushed to pieces of approximately 1.5 inches or smaller diameter. From there the coal is conveyed to the coal storage area and piled until used. Usually a 90-day supply of coal is stored. As it is needed, the coal is mechanically fed into reclaim hoppers and then again conveyed by belt into coal bunkers directly above the pulverizers. The coal is fed from the bunkers down through feeders, which control the flow, and then into the pulverizers, where it is pulverized into very fine particles. This coal dust is then transported by air flow up to the burner locations in the four corners of the boiler and mixed with combustion air from the wind box. The coal-air mixture is then blown into the center of the boiler where a very intense, swirling fireball sustains the combustion process. At full load, Units 3 and 4 as proposed would each consume coal from mining area "C" at a rate of about 10,800 tons per day. This rate of combustion would release in the boilers approximately 7,573 million BTU's per hour, 16,070 pounds of SO_2 per hour, and 91,783 pounds of ash per hour. Approximately 18,356 pounds of ash per hour would be collected in the boiler and economizer hoppers.

As the coal burns in the center of the boiler, the heavier particles of combustion and clinkers fall to the bottom or the throat of the boiler. From there they drop into the bottom ash hopper. This hopper contains water which cools the clinkers and transports them to clinker grinders. After grinding, the bottom ash-water mixture is pumped to the ash ponds, where the ash settles out, and the water is decanted back through the system. The lighter particles (fly ash) and combustion gases are routed up through the boiler superheat and reheat areas, down through the economizer and air preheaters, and then to the wet venturi scrubbers. The gas is then reheated to 175+F and exhausted through induced draft fans to the stacks and then to the atmosphere.

The manufacturer and the applicants believe that the proposed scrubbers will limit SO_2 emissions to 1.0 pound per million BTU input or 7,573 pounds of SO_2 per hour. They also believe that the scrubbers will remove at least 99.5% of the particulates, emitting 397 pounds per hour.

6.2. Construction

6.2.1. Foundations and Construction Methods

The ground beneath Units 3 and 4 would be excavated to a depth of about 30 feet to remove a coal seam about 10 feet thick. The excavated area for both units is approximately 700 feet by 300 feet in plan and would be back-filled with the excavated material to final plant grade.

All foundations, caissons, ground floor slabs and structures below grade would be of reinforced concrete construction.

As each foundation system is completed, related structural steel would be raised and equipment, piping, siding, wiring, etc. installed. The sequence is depicted on the Milestone Summary Schedule shown in Figure 6-2. Conventional construction equipment including trucks, bulldozers, scrapers, shovels, cranes, graders, rollers, caissons, drilling rigs, welders, air compressors, etc. is used.

6.2.2. Construction Schedule and Crew Size

Information concerning construction schedules for Units 3 and 4 is presented in the Milestone Summary Schedule (Figure 6-2). This schedule, prepared for MPC by Bechtel Corporation, is for Unit 3 with the schedule for Unit 4 being the same only one year later. The crew sizes can be found in Figure 6-4. This figure assumes a November 1, 1974 starting date for actual construction. It should be noted that if Units 3 and 4 are approved, the starting date for construction will be sometime during 1975. Therefore, if the same completion date is maintained the various crew size estimates must be increased.

If, however, the completion dates are moved ahead a length of time corresponding to that of the starting dates, the crew size estimates may be valid. Figure 6-3 contains total manual and non-manual personnel data for the construction of Units 3 and 4 on a monthly basis. The term "non-manual personnel" refers to supervisory, clerical, engineering, etc., personnel, while the term "manual personnel" means craft laborers. Figure 6-4 gives data for crew sizes of each manual craft on the same monthly basis. By referring to the Milestone Summary Schedule, the date for a given activity may be determined. Then by using that date and referring to the crew size curves of Figures 6-3 and 6-4 an estimate can be obtained of how many workers will be on the site at a given time and what their skills are. A brief description of the various crafts shown in the figures follows (U.S. Dept. of Labor 1965):

1) Boilermakers

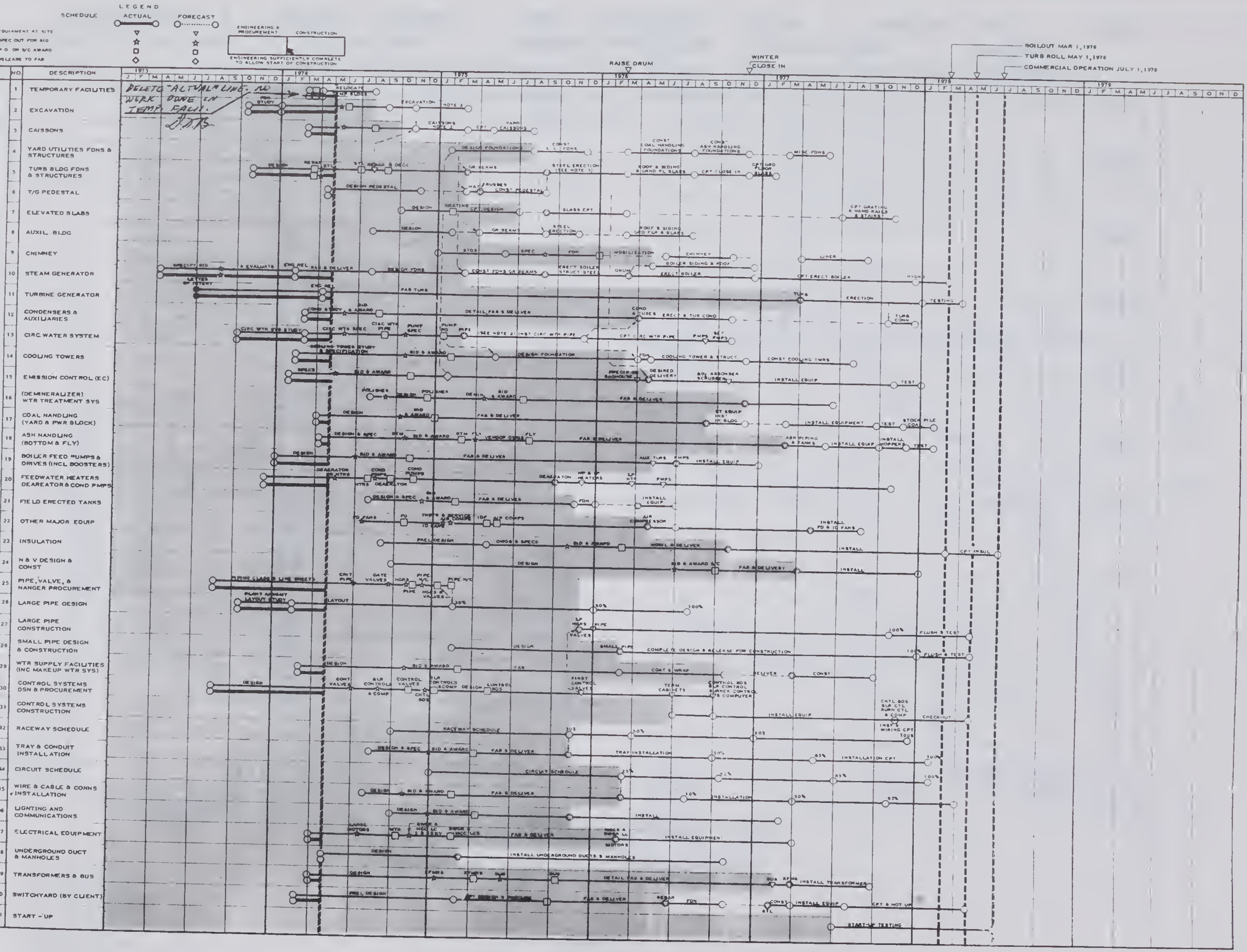
   Assemble, and repair boilers, pressure vessels, tanks, and vats in the field.

2) Carpenters

   Construct, erect, install, and repair structures and fixtures of wood, plywood, and wallboard, using carpenter's handtools and power tools.

3) Electricians

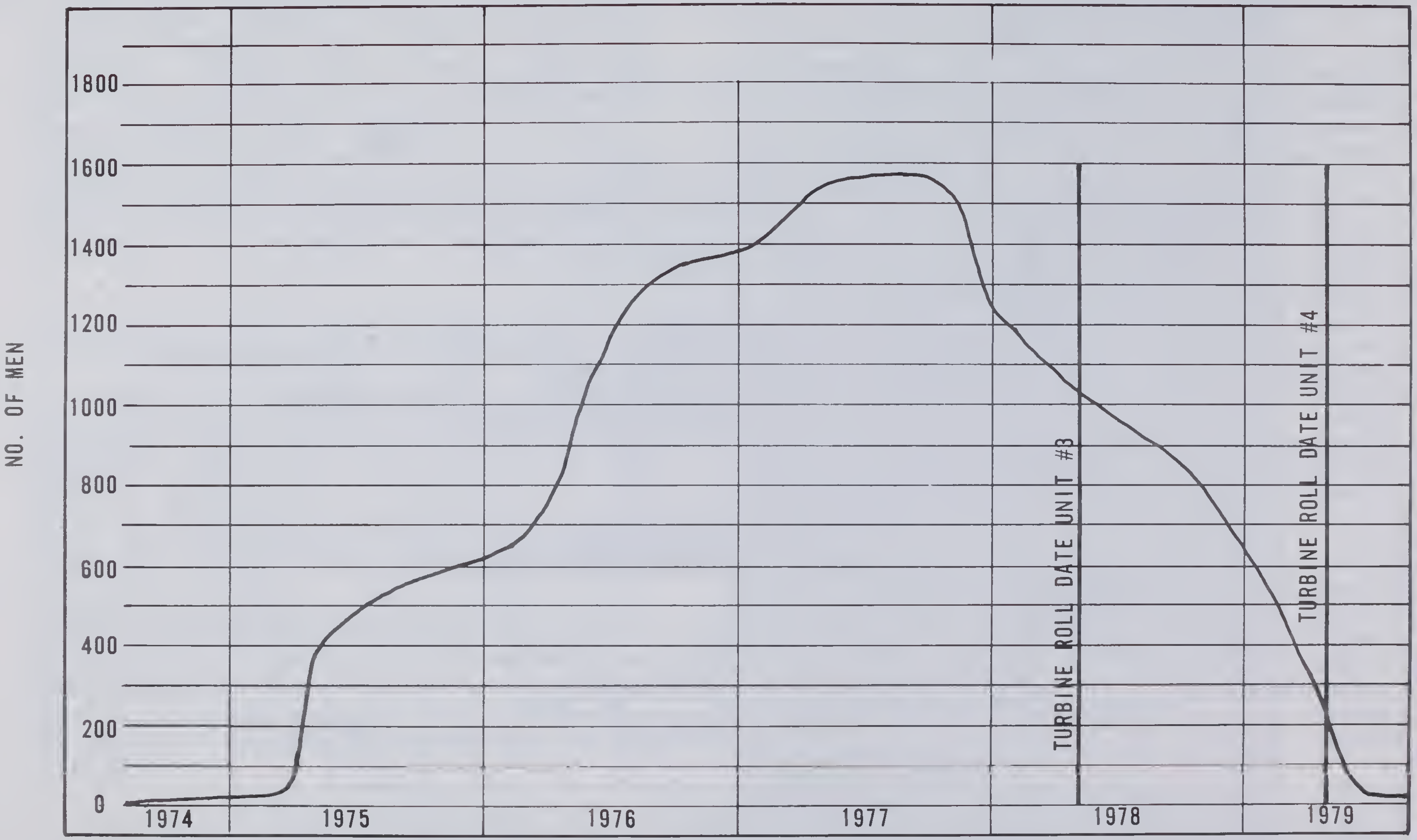
   Plan layout and install and repair wiring, electrical fixtures, apparatus, and control equipment.



MILESTONE SUMMARY SCHEDULE FOR COLSTRIP # 3

FIGURE 6-2

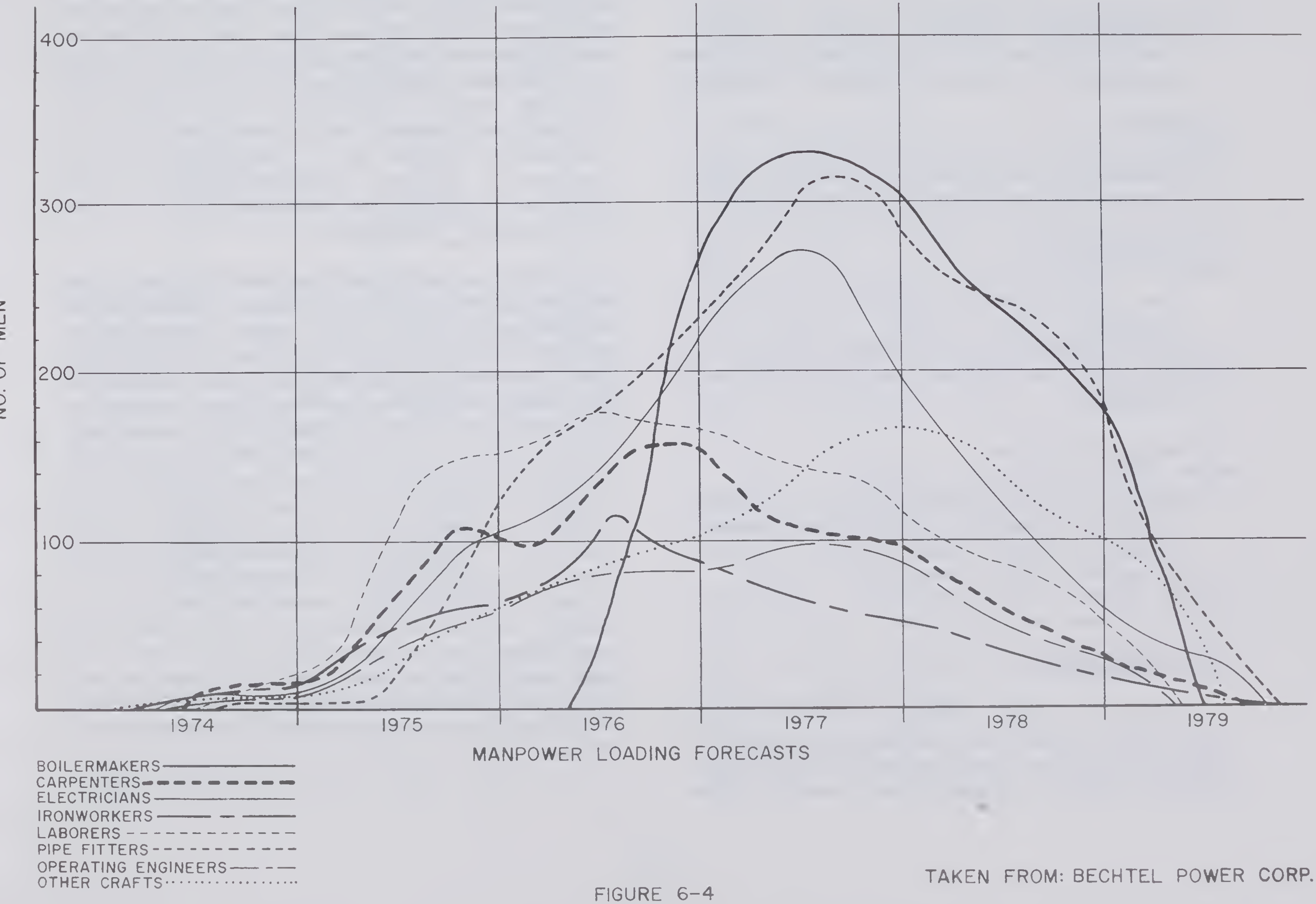
NOTES: 1. CURVE INCLUDES: A. BECHTEL & SUBCONTRACT MANUAL & NONMANUAL PERSONNEL. B. DISTRIBUTABLE MANHOURS. 2. CURVE EXCLUDES: CONTINGENCY MANHOURS. 3. BASED ON SEPT. 1, 1974 START OF RELOCATING TEMPORARY FACILITIES AND A NOV. 1, 1974 START OF EXCAVATION FOR UNITS 3 & 4.



MANPOWER LOADING FORECAST
TOTAL MANUAL & NONMANUAL PERSONNEL

FIGURE 6-3

NOTES: 1. CURVE DOES NOT INCLUDE CONTINGENCY. 2. CURVE INCLUDES DISTRIBUTABLE MANHOURS. 3. BASED ON M.H. FOR UNITS 3&4 ONLY. 4. SCHEDULE BASIS: REV. #0 OF UNIT #3 MILESTONE SUMMARY SCHEDULE WITH UNIT #4 1 YEAR LATER THAN UNIT #3 SCHEDULE.



MANPOWER LOADING FORECASTS

FIGURE 6-4

TAKEN FROM: BECHTEL POWER CORP.

4) Ironworkers

Perform any combination of the duties to raise, place, and unite girders, columns, and other structural-steel members to form completed structures or structure frameworks.

5) Laborers

Perform any combination of tasks to assist skilled workers engaged in construction.

6) Pipefitters

Lay out, fabricate, assemble, install, and Maintain piping systems, fixtures, and equipment for steam, hot water, heating, cooling, lubricating, and industrial processing systems.

7) Operating Engineers

Operate several types of power construction equipment, such as compressors, pumps, hoists, derricks, cranes, shovels, tractors, scrapers, or motor graders.

6.3. Coal Content

Coal is an organic deposit consisting mostly of altered vegetative material. The conditions under which it was deposited and its post-depositional history determine the character of the rock. Coal is classified by rank according to amount of fixed carbon and heat content on an ash free basis, and also classified by sulfur (S) content. Rank increases from lignite, which has the lowest heat content and fixed carbon, through subbituminous and bituminous to anthracite, which has the highest fixed carbon and generally the highest heat content. Sulfur grades are: low, $<1\%$ S; medium, 1% to 3% S; and high, $>3\%$ S. The quality of coal and its suitability for certain purposes are also determined by its ash content and elemental composition.

The amount of coal that must be handled and burned to obtain a given amount of heat energy is determined by its heat content expressed in British thermal units (BTU) per pound of coal. Ash, the unburned matter left after combustion, is mostly inorganic material such as clay and silt deposited with the coal. Ash is undesirable because it increases handling costs, contributes to air pollution, and can cause fouling of the boilers. Sulfur occurs as metal sulfides (especially in FeS_2) and sulfates ($FeSO_4$ and $CaSO_4$) and as a constituent of the organic material. Sulfur is also undesirable principally because it creates air pollutants (mostly SO_2) when coal is burned and water pollution in and around areas where high sulfur coal is mined or stored. Almost all other elements occur in coal, mostly in trace amounts. These elements affect the properties of the coal, and some are potential pollutants.

Rosebud and McKay coals from the Colstrip area are mostly low-sulfur subbituminous. The values shown below are weighted averages for coal from the three mining areas (C,D, and E) from which the coal will be mined to fire Colstrip Units 3 and 4 if built (as received basis).

Moisture	25.6%
Ash	9.6%
Volatile Matter	29.7%
Fixed Carbon	35.1%
Heat Content	8,438 BTU/lb

Of the three mining areas, area C is the largest and contains the lowest quality coal. About 69% of the coal would come from this area, and burning it would produce the greatest impacts. Therefore, for many calculations assessing environmental impacts, area C coal values (See Table 6-1) are used. The average proximate analyses for mining area C coal are:

Moisture	25.65%
Ash	10.16%
Volatile Matter	29.70%
Fixed Carbon	34.47%
Heat Content	8,383 BTU/lb

The sulfur (S) content of the Rosebud seam is derived from 165 analyses from the three mining areas. The average weighted value (based upon acreage of the three mining areas and the mean for each area) is 0.84%, or 0.995 pounds of S per million BTU. For area C the average is 0.89%, or 1.06 pounds S per million BTU.

Many elements exist in coal in trace amounts. Since large quantities of coal would be burned if all four Colstrip units are built ($10x10^6$ tons/yr), appreciable amounts of trace elements are involved. Some of these elements are potentially toxic.

Fluorine occurs in coal and is released by burning. Extremely reactive, fluorine is combined with other elements in the coal and in effluents from the plant. Although fluorine concentrations in Colstrip coal have been reported as from less than one part per million (ppm) to 160 ppm, the best estimate, accepted by the Montana Air Quality Bureau is between 30 and 40 ppm.

Major radioactive trace elements are uranium, thorium, and radium-226. These elements occur in the Colstrip coal in quantities similar to many other rocks.

For a summary of the trace element concentrations in the Colstrip coal, see "Assumed Concentration column in Table 6-2.

Unlike liquid or gaseous fuels which are homogeneous substances, coal consists of different phases distributed in complex patterns within the seam. This heterogeneity exists at all scales from microscopic to the largest dimensions possible within the seam.

An investigation with a microscope upon a thin section (a slice of coal ground to a thickness of 3-5μ) reveals inorganic mineral

TABLE 6-1

COAL ANALYSIS FOR AREA C (AS RECEIVED BASIS) ROSEBUD SEAM

	%MOISTURE	%ASH	%VOLATILE MATTER	%FIXED CARBON	BTU/LB	%SULFUR
Number Of Values	93	93	93	93	93	93
Minimum Value	20.61	4.14	27.02	29.95	7365	.40
Maximum Value	30.75	18.36	35.26	38.42	9028	7.40
Mean Value	25.65	10.16	29.70	34.47	8383.24	.89
Median	25.40	9.96	29.63	34.42	8423	.80
Standard Deviation	1.488	1.764	1.154	1.361	244.001	.727

TABLE 6-2

ESTIMATED TRACE ELEMENT EMISSION RATES (FOR UNIT #3 OR #4)

Element	Assumed Concentration ppm	100% Cap Feed Rate lbs/hr	Percent Emitted	100% Cap Emission Rate lbs/hr	100% Cap Emission Rate g/sec
As (arsenic)	5	3.36	10	.336	.0423
B (boron)	65	43.7	5	2.185	.275
Ba (barium)	325	218	5	10.9	1.37
Be (beryllium)	0.5	.336	5	.0168	.0021
Br (bromine)	25	16.8	10	1.68	.212
Cd (cadmium)	0.2	.134	10	.0134	.00169
Cl (chlorine)	100	67.2	10	6.72	.847
Co (cobalt)	0.5	.336	1	.00336	.00042
Cr (chromium)	3	2.02	5	.101	.0127
Cu (copper)	7.5	5.04	5	.252	.0318
Eu (europium)	.08	.054	5	.0027	.00034
F (fluorine)	35	23.5	10	2.35	.296
Ga (gallium)	3	2.02	5	.101	.0127
Ge (germanium)	1.2	.807	10	.0807	.0102
Hf (hafnium)	0.8	.538	1	.00538	.000678

ESTIMATED TRACE ELEMENT
EMISSION RATES (FOR UNIT #3 OR #4)
(continued)

Element	Assumed Concentration ppm	100% Cap Feed Rate lbs/hr	Percent Emitted	100% Cap Emission Rate lbs/hr	100% Cap Emission Rate g/sec
Hg (mercury)	0.2	.134	90	.121	.0152
La (lanthanum)	3.5	2.35	1	.0235	.00296
Li (lithium)	10	6.72	5	.336	.0423
Mn (manganese)	100	67.2	5	3.36	.423
Mo (molybdenum)	1.2	.807	10	.0807	.0102
Nb (niobium)	0.8	.538	1	.00538	.000678
Ni (nickel)	35	23.5	5	1.175	.148
Pd (lead)	5.0	3.36	10	.336	.0423
^{226}Ra (radium)	0.3 pCi/g	92×10^{-6} Ci/hr	5	4.6×10^{-6} Ci/hr	1.28×10^{-9} Ci/hr
Sb (antimony)	1.0	.672	10	.0672	.00847
Sc (scandium)	1.0	.672	1	.00672	.000847
Se (selenium)	1.0	.672	10	.0672	.00847
Sm (sarmarium)	0.5	.336	5	.0168	.00212
Sr (strontium)	225	151	1	1.51	.190
Ta (tantalum)	.25	.168	1	.00168	.000212
Tb (terbium)	.06	.040	5	.002	.000252

ESTIMATED TRACE ELEMENT EMISSION RATES (FOR UNIT #3 OR #4)

(continued)

Element	Assumed Concentration ppm	100% Cap Feed Rate lbs/hr	Percent Emitted	100% Cap Emission Rate lbs/hr	100% Cap Emission Rate g/sec
Ti (titanium)	400	269	1	2.69	.339
Th (thorium)	2.5	1.68	1	.0168	.00212
U (uranium)	1.0	.672	1	.00672	.000847
V (vanadium)	6	4.03	5	.202	.0255
Y (ytterium)	2.5	1.68	5	.084	.0106
Yb (ytterbium)	.15	.100	10	.01	.00126
Zn (zinc)	50	33.6	10	3.36	.423
Zr (zirconium)	16	10.8	1	.108	.0136

phases (sulfides, silicates, and others) and several organic phases (the domimant coal material). These phases have different compositions and properties and their relative proportions determine the characteristics of the coal. The iron sulfide phase (pyrite or marcasite), for instance, contributes a large portion of the sulfur. Pyrite contains 53% sulfur, whereas some organic phases are essentially sulfur-free. On a larger scale, pieces and agglomerated masses of pyrite are easily observed as are the bands of different organic phases. The coal may also vary greatly within a distance of a few feet and show a major difference in composition from the top to the bottom of the seam. Fracture zones, faults, and other special areas may be the sites of greater pyrite concentration or other variation. The heterogeneity of the swamp that produced the organic matter influences the variability of the existing coal.

Knowledge of the Colstrip coal deposit, except where mined, is derived from core drilling. As noted previously, portions of areas C, D, and E have been cored on a 1,000-foot square grid pattern. The core are relatively small samples. Numerous small samples can provide reliable mean values for large areas but cannot provide information on local variability. Units 3 and 4 would burn about 903 tons of coal per hour when operating at capacity and using area C coal. The area within four core holes (a 1,000-ft. square) would provide enough coal to operate both units for about 40 days. Large samples (on the order of thousands of pounds) could provide more reliable mean values for a local area and could be used to better understand local patterns of variability, but such smaples can be taken only from open mines. Many more cores spaced much more closely could provide the same information but costs would be prohibitive. Therefore, although mean values for entire areas are known reasonably well, the heterogeneity of the coal at the scale which influences hourly, daily, and monthly variations in mean sulfur emissions and other variables is unknown.

6.4. Design Criteria and Functions of Major Plant Components

6.4.1. Boilers

The proposed boilers or steam generators for Units 3 and 4 are controlled-circulation, radiant-reheat, balanced draft units which are manufactured by Combustion Engineering. Each will deliver approximately 5,000,000 pounds of steam per hour at 2,400 psi and 1,000°F., which should be sufficient flow to drive the turbines at maximum output. As proposed, the boilers are pulverized coal type units which utilize modified tangential type burners. This design has proven to be effective in reducing the production of NO_2 compounds, and the manufacturer guarantees that each unit will produce no more than 0.7 pounds of nitrogen oxide (NO_2) per million BTU input (which equals 5,301 pounds NO_2 per hour with 7,573 million BTU's per hour).

6.4.2. Turbine Generators

The proposed turbine-generator sets for Units 3 and 4 are 700 MW/unit (nominal). These units have not yet been designed, so specific information concerning design and performance is not available.

The turbine generators for Units 1 and 2 are General Electric Company tandem-compound, reheat, two-flow condensing machines. They have a guaranteed nameplate rating of 332,922 KW when supplied with 2,400 psi and 1,000°F inlet steam, one inch of mercury exhaust pressure, zero percent makeup, and six stages of feedwater heating. The maximum throttle flow is expected to be 2,464,261 pounds of steam per hour, which should develop 358,371 KW at 3.5 inches of mercury exhaust pressure. The generators for Units 1 and 2 are to be direct-connected with liquid cooled stator and fan cooled rotor and are designed with a rating of 377,000 KVA at 22,000 volts. If approved, the 700 MW Units 3 and 4 are expected to be similar to but larger than Units 1 and 2.

6.4.3. Cooling System

The condensers for proposed Units 3 and 4 would be similar to the condensers for Units 1 and 2 at Colstrip. These condensers of the single-shell, double-pass surface type with divided water boxes, are manufactured by DeLaval Turbine, Inc. At full load on the turbines, the condensers are designed to produce an exhaust pressure of 3.5 inches of mercury when operating with 83+F. circulating water. The condensers for Units 3 and 4 would be designed for a circulating water flow rate of about 230,000 gpm. Proposed waste heat removal from the turbine steam cycle would be by a closed loop cooling system using an induced draft evaporative cooling tower.

6.4.4. Emission Control System

6.4.4.1. Stack Parameters

Stack design can have a significant effect on the dispersion of all pollutants leaving the plant with the combustion gases. As proposed, Units 3 and 4 would each have a 525-foot high reinforced concrete stack. The top inside diameter would be 24 feet, which is sufficient to provide an exit velocity of about 5,972 fpm. The temperature of the exit gas is expected to be about 175°F. Each stack would contain an independently supported insulated steel lining and would have one opening for each of the associated scrubber systems, together with the test parts required by the Environmental Protection Agency (EPA).

6.4.4.2. Description of Control Efficiencies

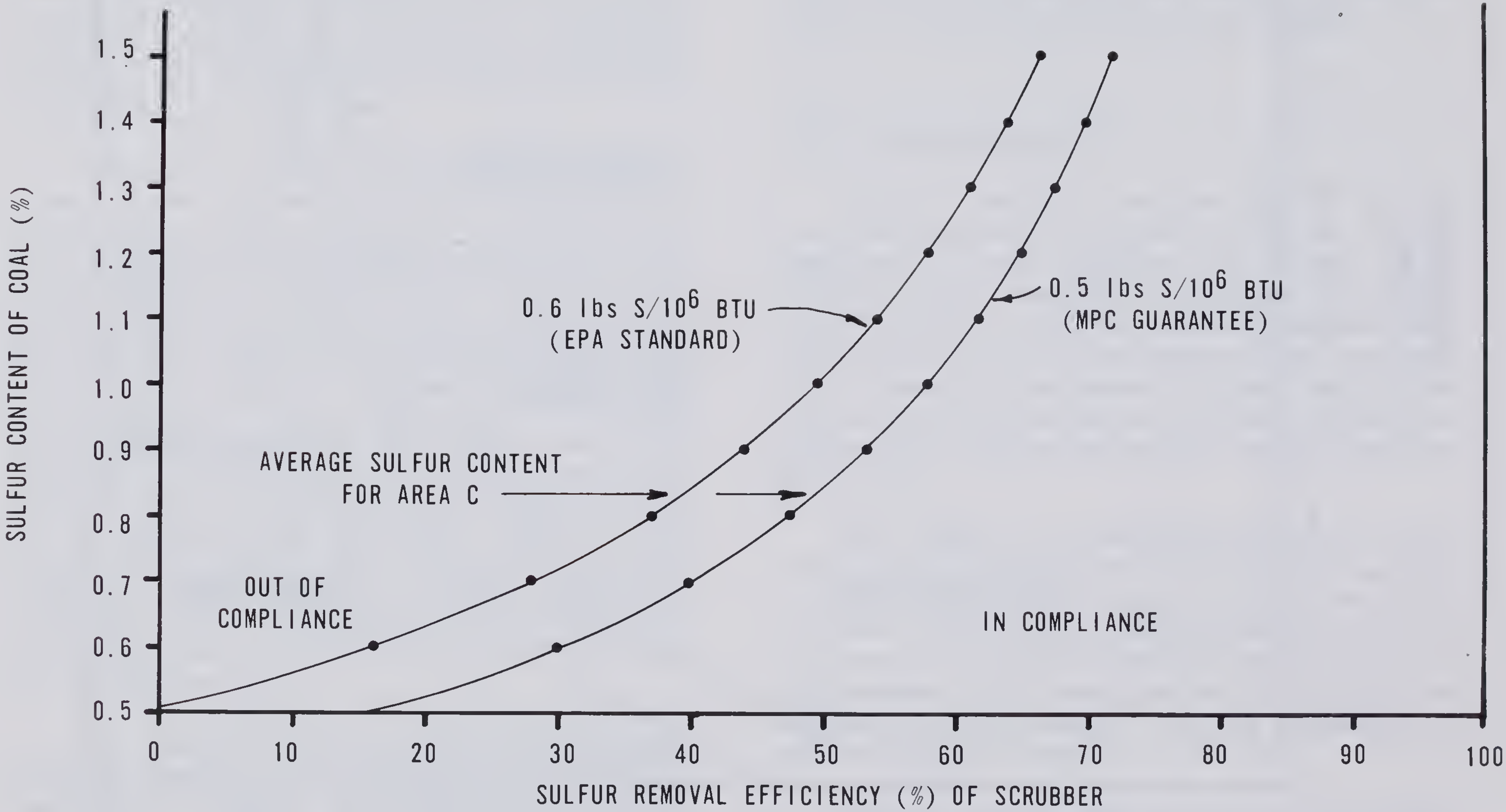
From the latest information and data concerning boiler design, scrubber design and coal content analysis for mining area "C", Figures 6-5 and 6-6 were derived.

Figure 6-5, "Removal Efficiency to Achieve Compliance With Sulfur Emission Standards," shows the removal efficiency of SO_2 necessary to meet the air quality standards for various sulfur content in the coal. It also shows what the removal efficiency must be to achieve the level of one pound per SO_2 emitted per million BTU's guaranteed by the vendor. For example, if the sulfur content reaches 1.2%, the control equipment must have a 58% sulfur removal efficiency in order to comply with the EPA standard. This figure is based on area "C" coal which has the lowest BTU content, the highest sulfur content, and the highest ash content average of the coal from areas "C", "D" and "E".

For the particulates, the applicants' design control efficiency calls for greater than 99.5% removal. Figure 6-6 "Removal Efficiency to Achieve Compliance With Particulate Emission Standards," shows the removal efficiency necessary to meet the standards for various values of ash content in the coal. This figure is also based on area "C" coal and assumes that 80% and 100% of the ash content of the coal will reach the scrubbers in particulate form. According to the final report of the Particulate and Sulfur Dioxide Pilot Plant Test Program for the Colstrip Generating Station conducted by Combustion Equipment Associates, the pilot plant successfully removed 99.9% of the particles in the 4 to 5 micron range, 99% in the 3 to 4 micron range, 98% in the 2 to 3 micron range, 95% in the 1 to 2 micron range, and 90% in the sub-micron range. The applicants and the manufacturer believe that because of boiler design the oxides of nitrogen will be well below state and federal standards, even though there is no special removal equipment for them. Likewise they believe carbon monoxide should be well below the standards.

6.4.4.3. Trace Element Emission Rates

In establishing the estimated emission rate for each trace element shown in Table 6-2, a percentage emission was applied to the feed rate. This percentage figure was determined by making several assumptions based upon the characteristics of the scrubber and the volatility of the element or its oxide.

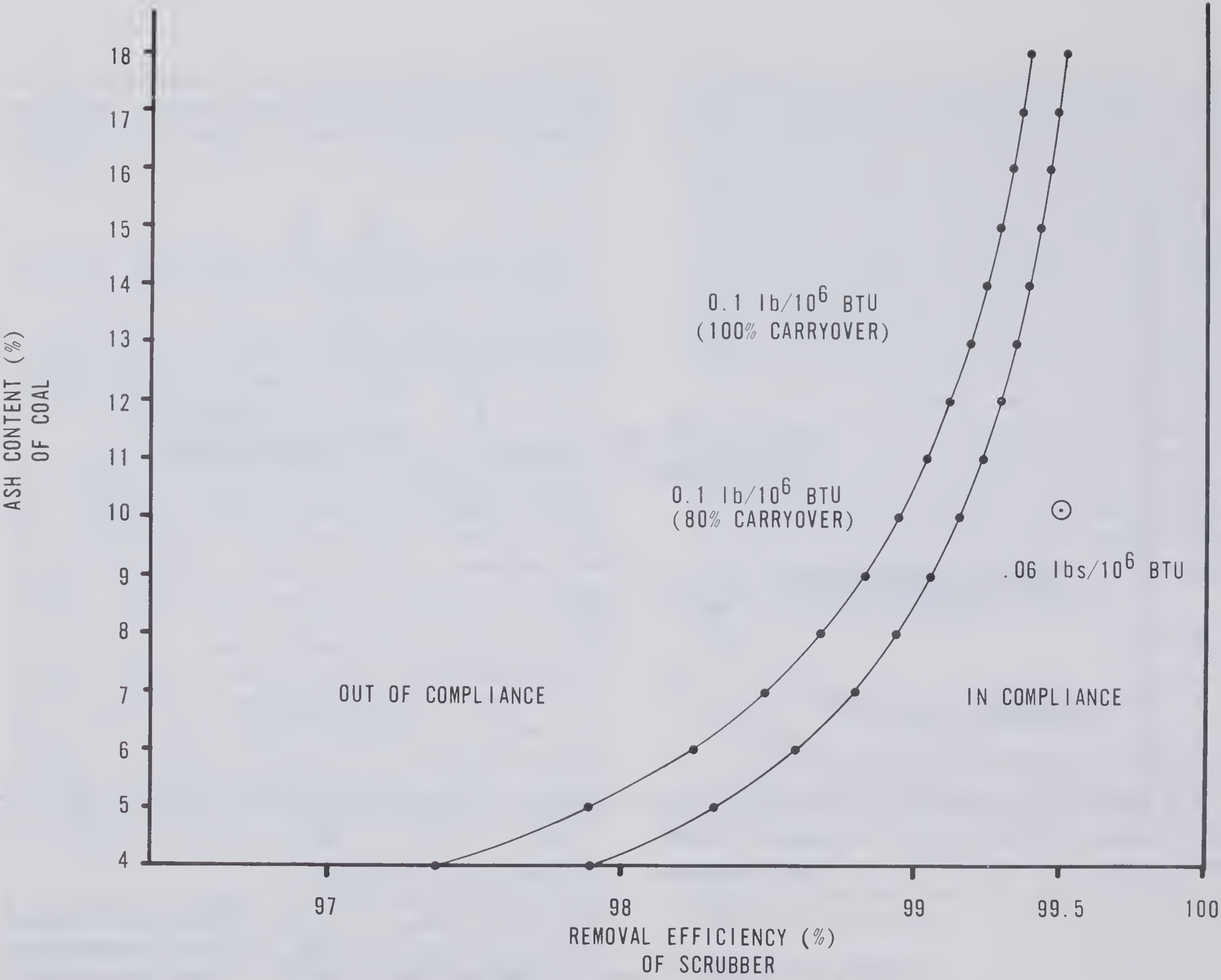


NOTE: 1.0 lb S=2.0 lb SO_2

Curves shown on this graph correspond to 1.2 lbs SO_2 and 1.0 lbs SO_2

REMOVAL EFFICIENCY TO ACHIEVE COMPLIANCE WITH SULFUR EMISSION STANDARDS
AREA C COAL (8383 BTU/lb)

FIGURE 6-5



REMOVAL EFFICIENCY TO ACHIEVE COMPLIANCE WITH PARTICULATE EMMISSION STANDARDS
AREA C COAL (8383 BTU/lb)
FIGURE 6-6

Refractory elements are assumed to be uniformily distributed throughout the fly ash and not concentrated in any size fraction. Their removal efficiency, therefore, should be that of the fly ash (99.5%). The use of 1% in calculating emissions allows for a small amount of concentration in the uncollected fly ash and represents the maximum likely emission.

The use of 10% emission for the volatile elements was arrived at by two rationales. The first assumes that all of the trace element is volatilized in the boiler and condensed upon submicron particles. Since the removal efficiency of the sub-micron particles in the scrubber is about 90%, the upper limit of trace element emission is 10%, given the above assumption. However, the trace elements also condense upon the larger particles (greater than one micron). The second rationale assumes complete condensation of the volatile trace elements and a concentration factor of ten in the particulate matter which escapes the scrubbers. Since the escaping particulate is less than 1% of the total particulate generated, 10% of the volatile trace elements is considered the maximum amount that could escape the control devices.

The intermediate elements are assigned an emission factor of 5% based upon the assumption that their behavior in the boiler and ducts is intermediate between that of the refractory and the volatile elements.

The emission factors are believed to be on the high side, and the intention here is to demonstrate the highest emissions likely to occur. The percentage figures applied as emission factors are not portrayed as being exact.

6.4.5. Sludge Disposal

One of the major problems inherent in flue gas desulfurization systems based on lime or limestone is the necessity to dispose of or utilize large quantities of sludge. At present, lime/limestone scrubbing systems generate a sludge with little commercial value. For coal-fired installations where efficient particulate removal is not installed upstream of the absorber, such sludges can contain large quantities of fly ash.

The amount of sludge generated by a given plant is a function of the sulfur and ash content of the coal, the coal usage, the on-stream hours per year (load factor), the mole ratio of lime or limestone added to the amount of SO_2 removed, the SO_2 removal efficiency, the ratio of sulfite to sulfate in the sludge, and the percentage of moisture in the sludge.

Ponding and landfilling currently provide the major mechanisms for disposal of lime/limestone sludge from flue gas desulfurization systems. Three problems are associated with this practice. First, the land use for waste disposal is aesthetically objectionable. Second, the sludge could provide varying degrees of surface and ground-water pollution depending upon chemical composition, solubilities, and the location, design, and operation of the disposal site. The potential water pollution problems derived from the chemical composition of the sludge may be classified as:

1) Soluble toxic species (toxic meaning elements which can cause health problems even at low concentrations),
2) Chemical oxygen demand,
3) Excessive total dissolved solids,
4) Excessive levels of specific species, e.g., sulfate and chloride, not generally thought of as toxic, and
5) Excessive suspended solids (some of which might dissolve later).

Thirdly, for land reclamation, most of the stable wastes will require only a cover material to support vegetation and prevent eventual erosion. However, some wastes are very resistant to dewatering and could reslurry in the pond or landfill. If this occurs it is likely that chemical fixation would become a necessary practice.

The alternative to disposal of scrubber sludges is development of commercially applicable utilization processes. Numerous programs in this area have been conducted through government - sponsorship and industry. Although many schemes have been proposed as uses for lime/limestone scrubber sludges, none are being currently utilized by the power industry.

6.4.6. Water Supply and Treatment System

The water supply system as proposed consists of a pumphouse on the Yellowstone River housing three 4,000 horsepower motor driven pumps, two pipe lines (one 26 inches in diameter for Units 1 and 2 and the other 36 inches in diameter for Units 3 and 4) extending approximately 30 miles to the plant site (one surge pond with approximately 50 days' emergency water storage capacity for Units 1 and 2) and a bypass system for going directly to the plant. The applicants are looking for another possible water storage site, but no firm plans have been made at this time.

The water treatment system contains various clarifiers, filters, chemical addition stations for cooling water, service water and town-use water, and finally a very sophisticated demineralization train for the closed cycle boiler water.

6.5. Material Flows

6.5.1. Plant Water Flow Analysis

Figures 6-7 and 6-9 indicate general water flows for Units 1 through 4 in winter and summer conditions, respectively. Detailed water flow diagrams are presented in Figures 6-8 and 6-10 for winter and summer conditions, respectively, for either Unit 3 or Unit 4.

It is somewhat doubtful that the cooling tower blowdown would be suitable for use in the scrubbers (see Figures 6-8 and 6-10). In this even the cooling tower blowdown would have to be disposed of to the ash pond and additional water would have to be supplied to the scrubbers.

6.5.2. Plant Air Analysis

A typical air flow analysis for either generating Unit 3 or 4 is illustrated in Figure 6-11. It may be observed that air enters the boiler where it participates in the combustion process. The gaseous products of combustion flow through the scrubbers to a reheater and are then forced out the stack by a fan. 8,436,000 pounds per hour of gaseous products are lost from the stack, and each of the five scrubbers must handle 1,205,143 pounds per hour.

6.5.3. Plant Coal Flow Analysis

Figure 6-12 is a material flow diagram for the major constituents of the coal which would be burned in proposed Units 3 or 4. The trace elements have not been accounted for in this figure because they were discussed in a previous section. Also, this figure was developed assuming 7,573 million BTU per hour heat released in the boiler and burning coal from mining area "C".

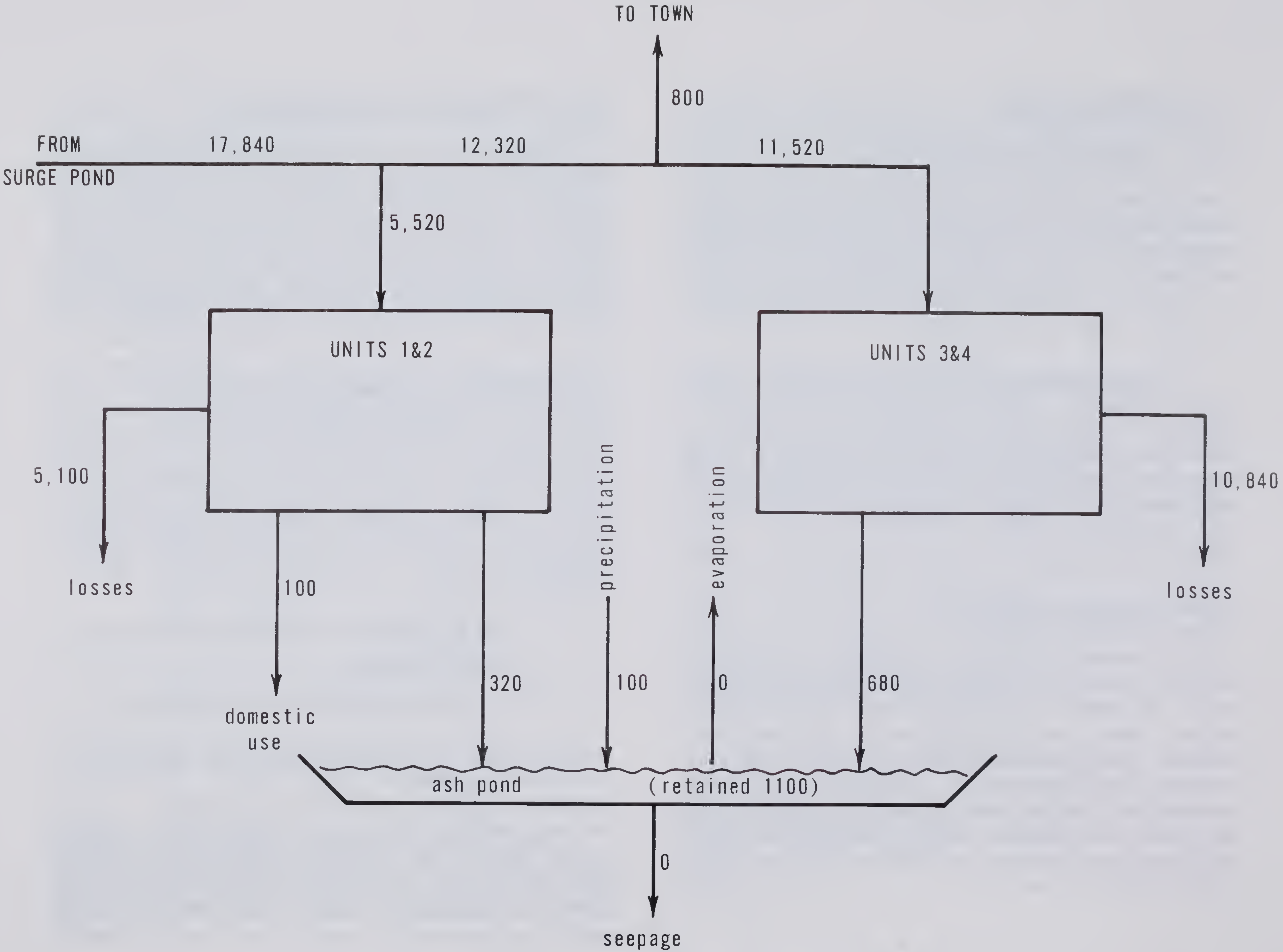
Assuming 23% excess combustion air, the manufacturer guarantees that only 0.7 lbs. of NO_x per million BTU heat release will be emitted, or 5,301 pounds NO_x per hour in this case. It is not known exactly how much carbon monoxide will be formed, which depends both on the amount of excess air and on the boiler design. Other assumptions made in developing this flow diagram were:

1) 20% ash removal in the boiler and economizer hoppers,

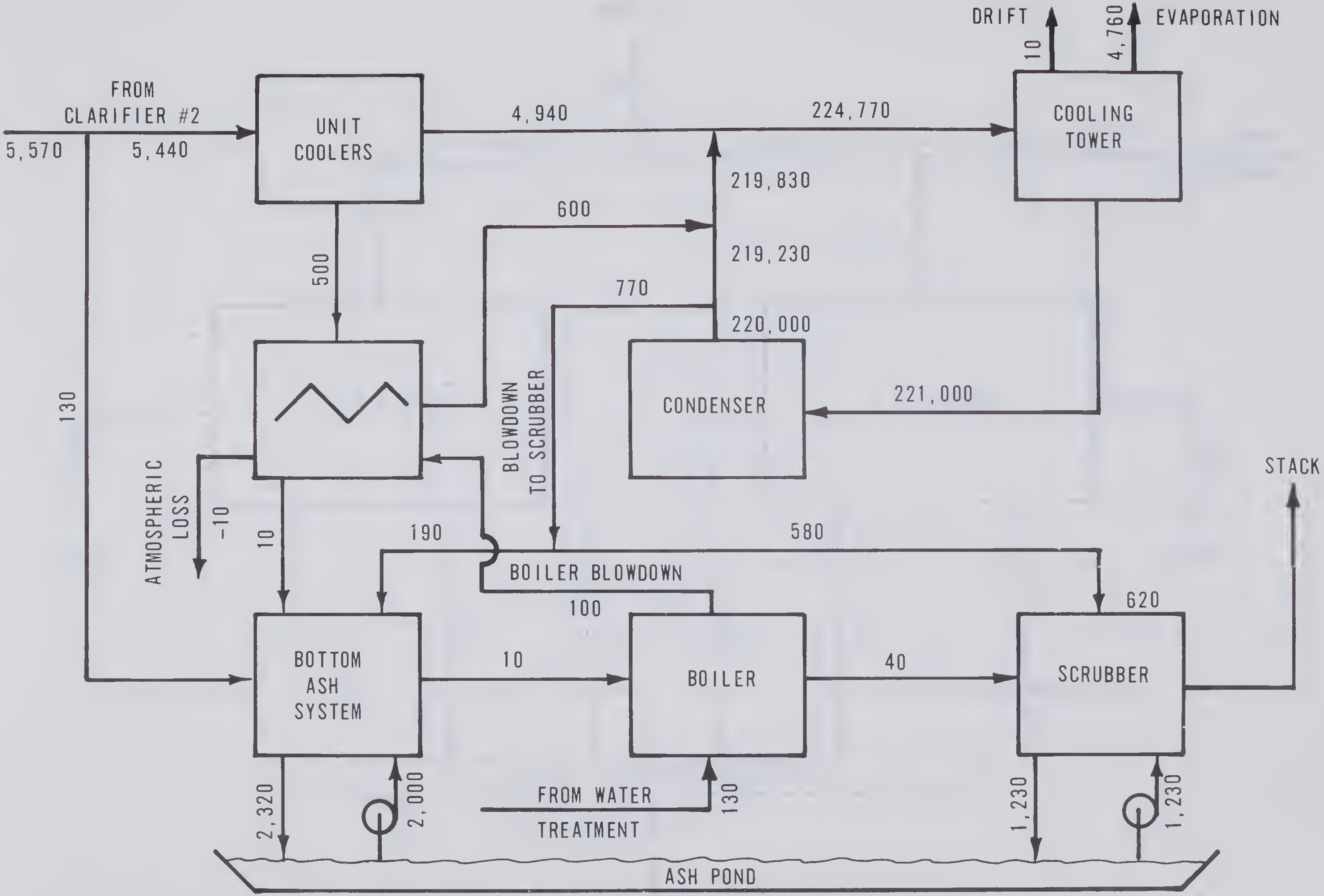
2) 99.5% ash removal in the scrubbers, and

3) 40%, 50% and 60% removal of SO_2 in the scrubbers.

The SO_2 removal in the scrubbers will depend on the quantity of calcium, potassium, and sodium in the fly ash. If the alkalinity in the fly ash varies considerably, then some method probably would be employed to maintain the desired level.

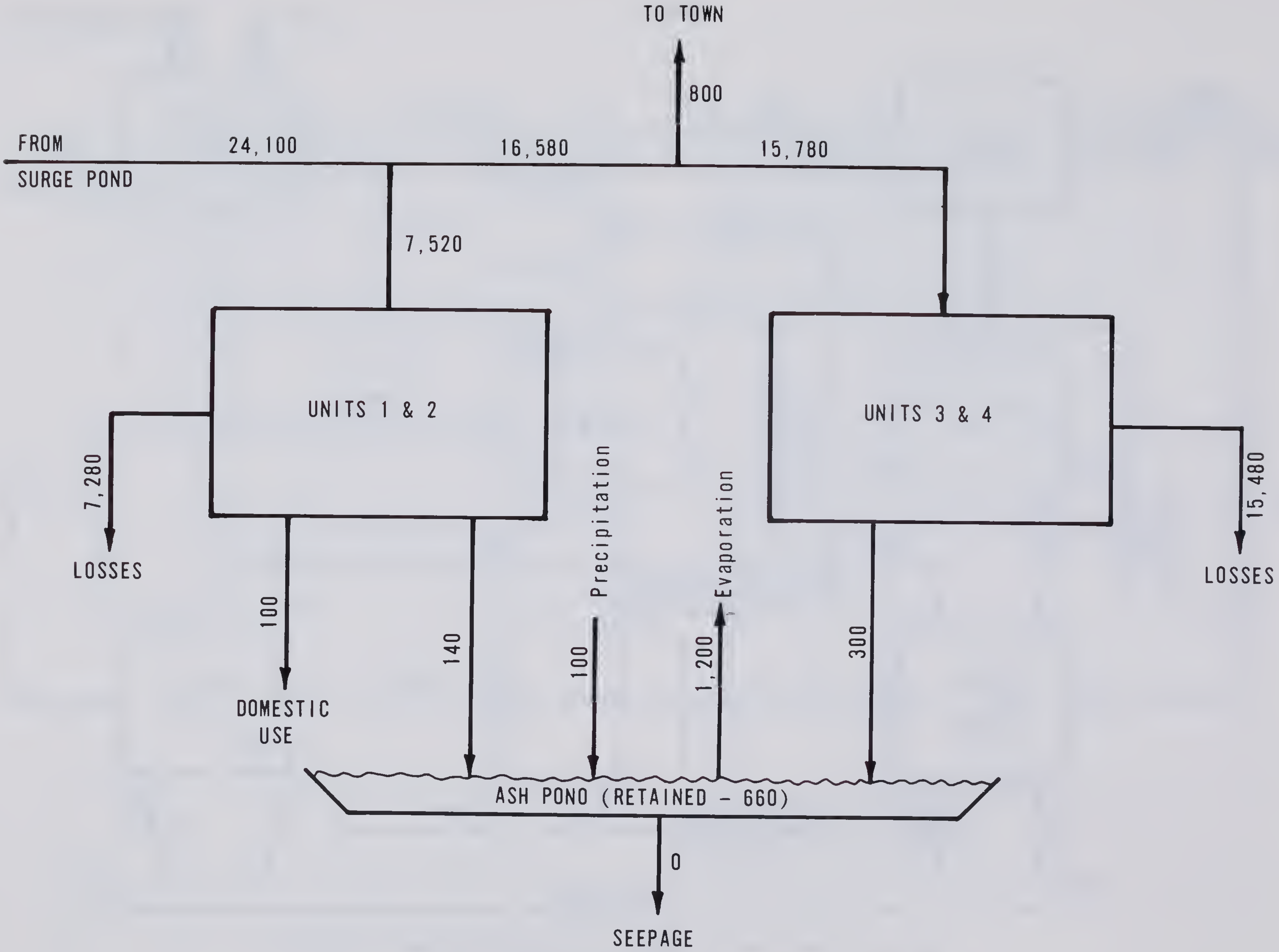


WINTER WATER BUDGET FOR OVERALL COMPLEX
(All Values are GPM)
FIGURE 6-7



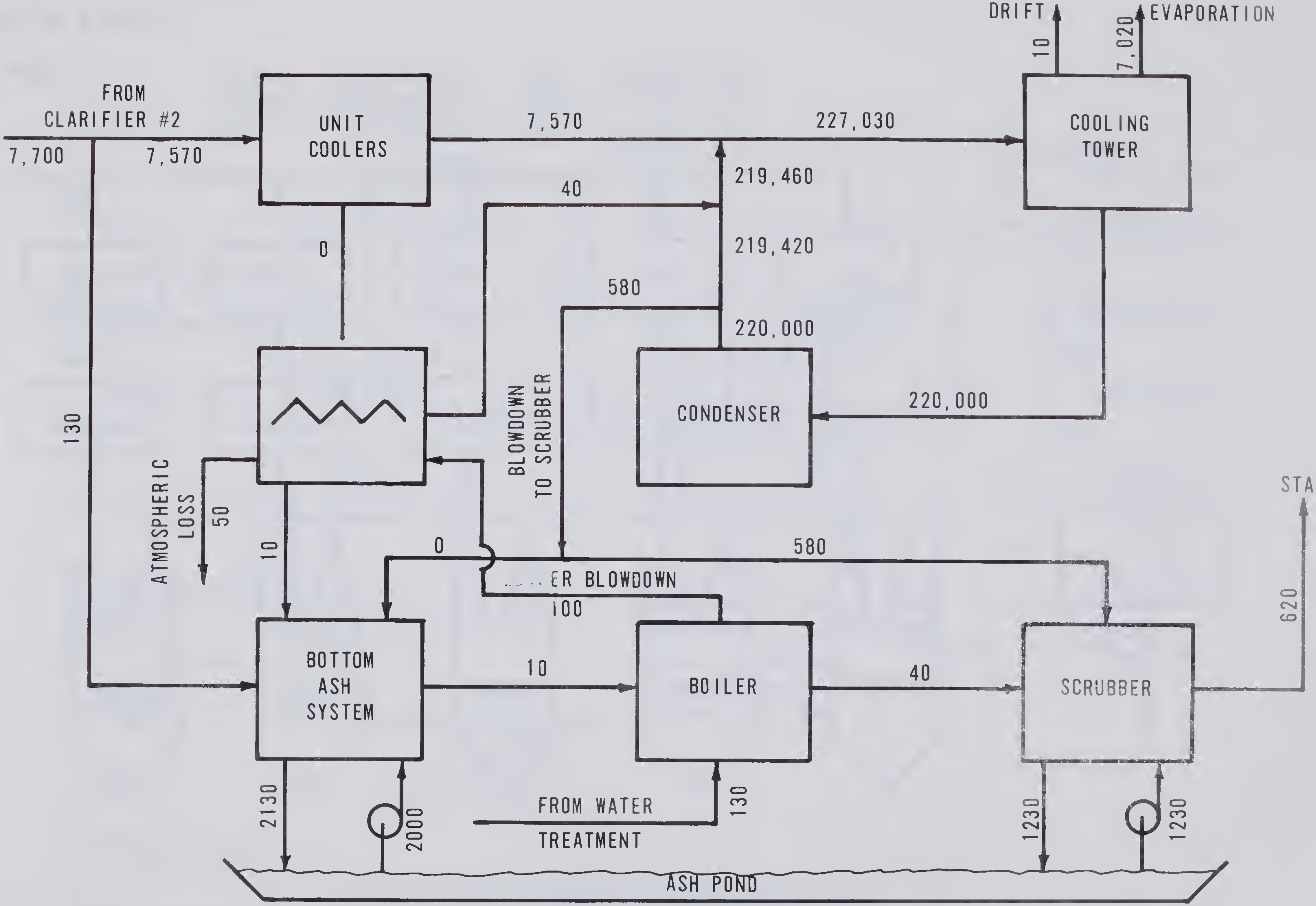
DETAILED WINTER WATER BUDGET FOR GENERATING UNIT #3 OR #4
(VALUES ARE GPM)

FIGURE 6-8



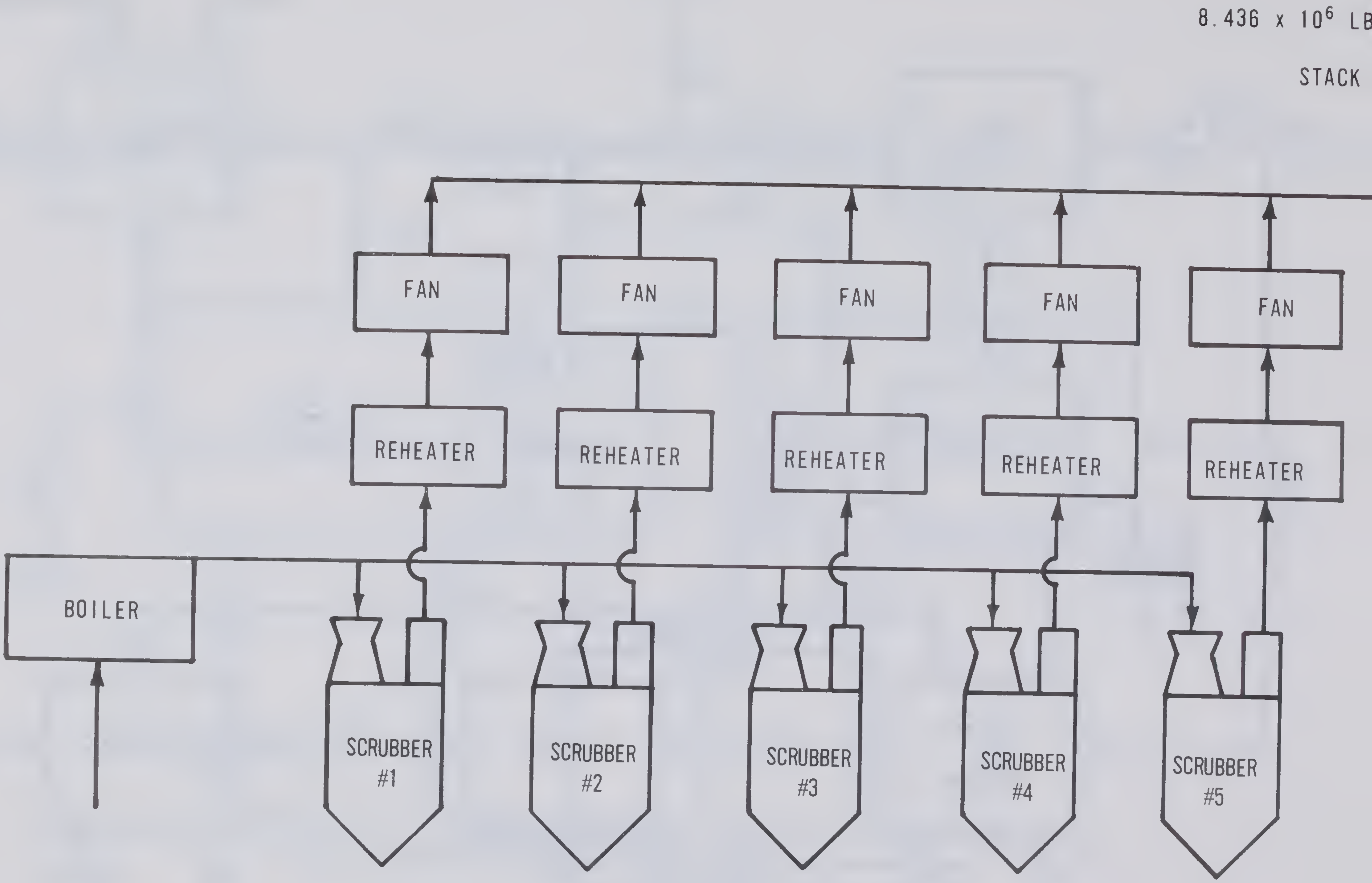
SUMMER WATER BUDGET FOR OVERALL COMPLEX
(VALUES ARE GPM)

FIGURE 6-9



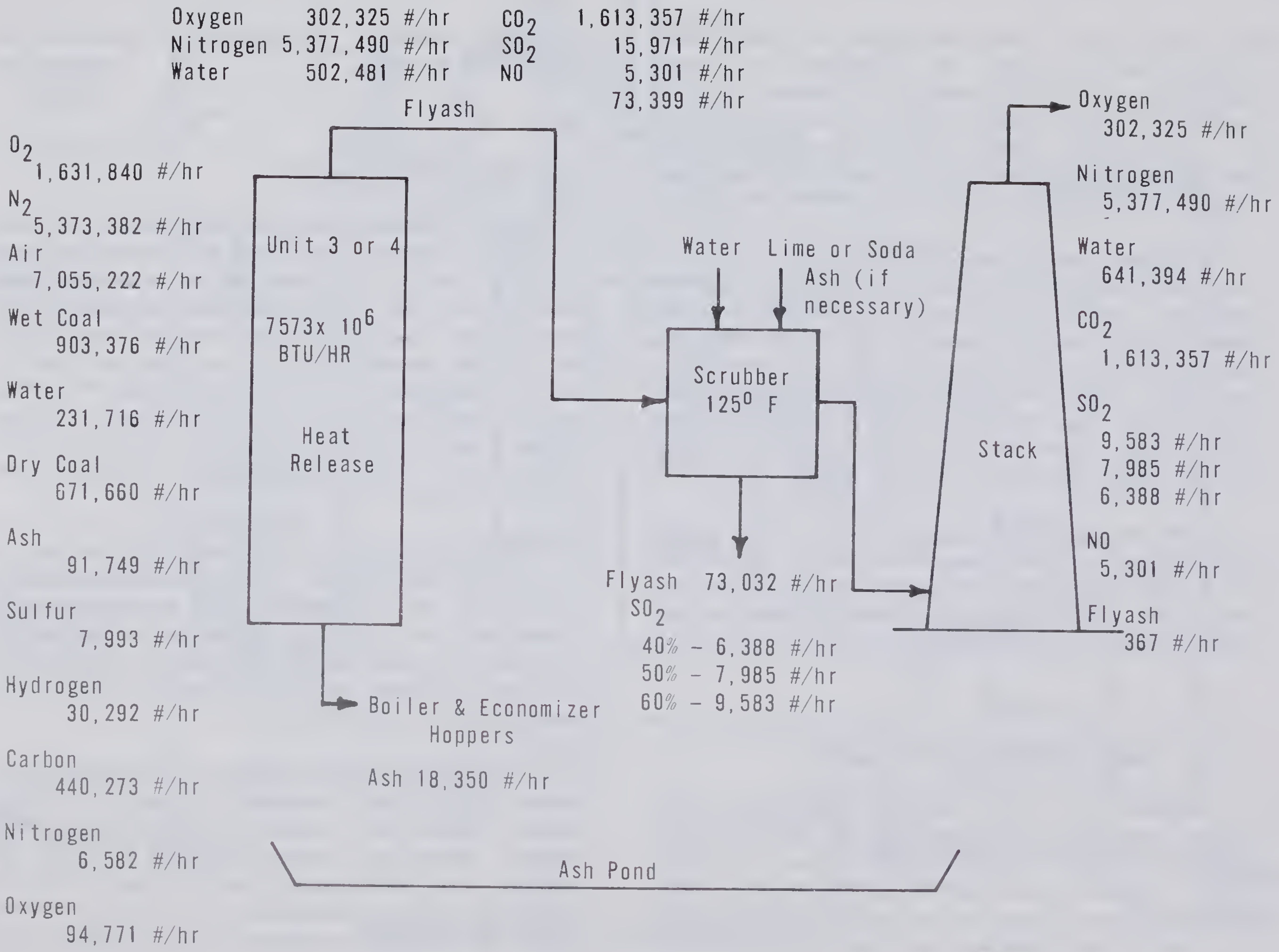
DETAILED SUMMER WATER BUDGET FOR GENERATING UNIT #3 OR #4
(ALL VALUES ARE GPM)

FIGURE 6-10



AIR FLOW BUDGET FOR GENERATING UNIT #3 OR #4

FIGURE 6-11



Unit Coal Flow Diagram

FIGURE 6-12

The method chosen would determine the final form of the sulfur salts. If limestone is used, insoluble salts will probably be formed, but, if sodium carbonate (soda ash) is used, water soluble salts will result. Neither the manufacturer nor the applicants indicated a need for this type of injection system.

Knowing the ultimate and proximate analysis for the coal and using 23% excess air, a stoicheometric balance was done to determine the quantity of air for combustion. Then, from the coal analysis and using the given assumptions, the flow rates for the given constituents were determined. From Figure 6-12 it can be seen that all of the waste material which is not emitted via the stack will go to the ash pond.

The amount of water vapor going up the stack will depend on the temperature in the scrubber. At 125°F, assuming the gases to be saturated, about 641,394 pounds per hour will be carried along with the rest of the flue gases.

6.5.4. Plant Chemicals Flow Analysis

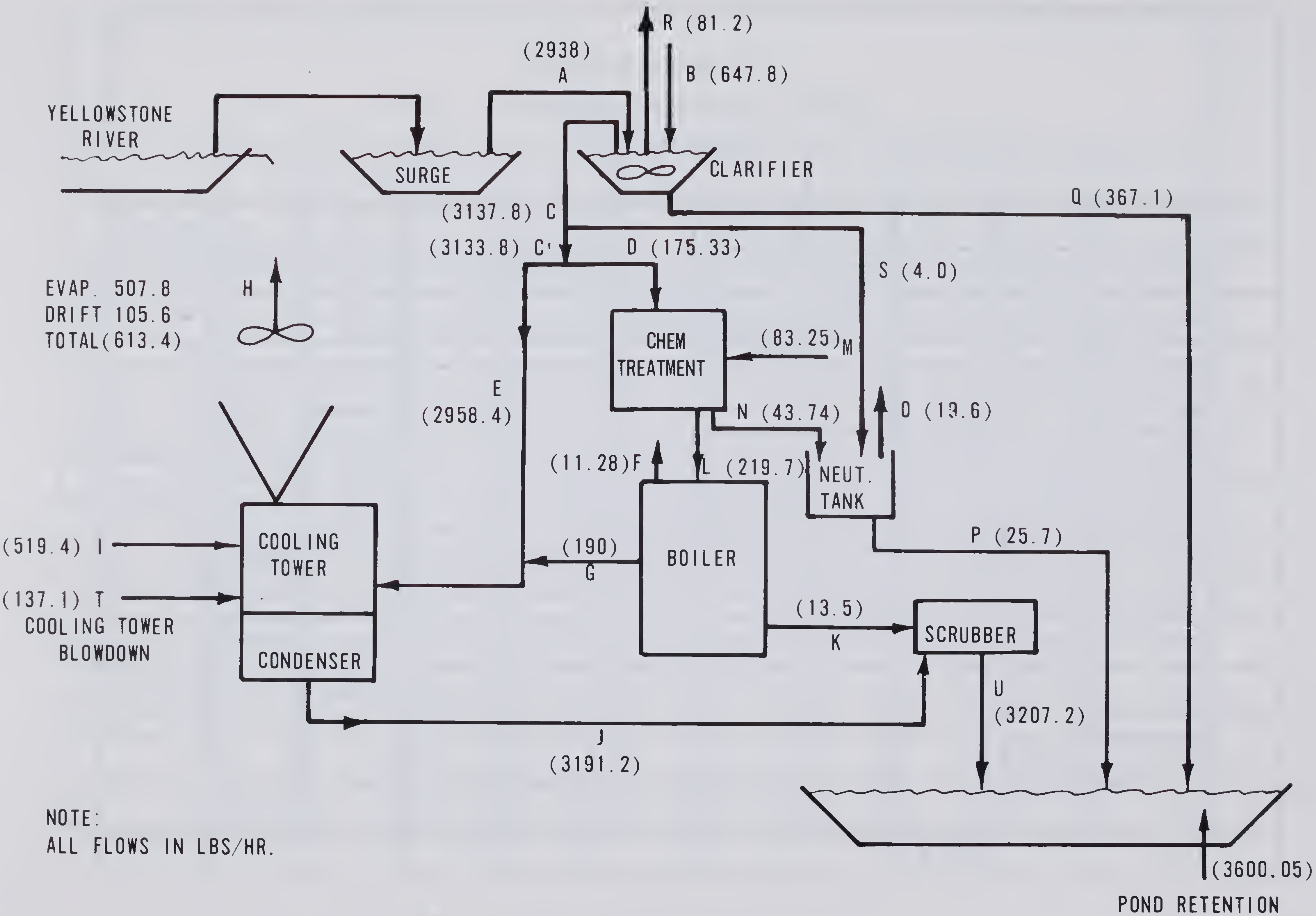
Figure 6-13 is a chemical flow balance for either proposed Unit 3 or Unit 4. All flows are given in pounds per hour. The values in parenthesis beside each letter indicate the total chemical flow at that point in the system. Table 6-3, which corresponds to Figure 6-13, gives a detailed breakdown of the various chemicals and quantities of each.

6.6. Operation Schedule

The current plans of the Colstrip Project management are to depreciate all of the units at Colstrip over a 37-year period after each unit startup and to operate the units for at least that long. Since these will be base load units, the plan of operation is to run them continuously at a high load level, utilizing smaller thermal plants and hydro plants in the system to accommodate changes or higher peaks in load. This will result in a high annual load factor for the Colstrip units.

As time goes by, increased size and new technology may permit greater efficiencies in this type of generation, and it would be less economical to run the older units at the high load factor. This means that, as the years go by, the load factor of the Colstrip units may be decreased.

The Federal Power Commission's Hydroelectric Power Evaluation contained a summary of operational costs for steam-electric fossil-fueled plants, based on a 30-year service life. In this report, the FPC assumed that the units would be operated over a relatively high range of annual plant load factors through the first half of the



NOTE:
ALL FLOWS IN LBS/HR.

CHEMICAL BALANCE FOR COLSTRIP #3 OR #4

FIGURE 6-13

TABLE 6-3

CHEMICAL BALANCE FOR UNIT #3 or #4

FLOWS IN LBS/HR

	A	B	C	C^1	D	E	F	G	H	I
Ca	234.5		234.5	234.2	13.11	221.1		13.11	10.2	
Mg	78.5		78.5	78.4	4.4	74		4.4	3.4	
Na	229.4		229.4	229.1	12.82	216.3		29.7	10.6	
NH_3								.051	.051	
SO_4	683	86.65	770	769	43	726		108.2	57.7	499.6
Cl	36.7	1.42	38.13	38.1	2.1	36		2.4	2.55	19.6
HCO_3	764.6		676.8	675.9	37.8	638			16.1	
CO_2	621.8		540.6	539.9	30.2	509.7	11.28		507.8	
SiO_2	60.15		60.15	60.1	3.4	56.7		3.4	2.55	
PO_4								.081		
Suspended Solids	229.4									
Cl_2									2.44	
Alum		47.9								

TABLE 6-3 (Cont.)

FLOWS IN LBS/HR

	A	B	C	C^1	D	E	F	G	H	I
Polyelectrolyte		2.04								
FC		.032	.032	.031	.0017	.03		.093		.003
Cu		.032	.032	.031	.0017	.03		.024		.112
Zn								.01		.043
Sn								.0003		.0015
Cr										.0013
Ni		.003	.003		.0002	.0033		.0025		.0009
Mn								1×10^{-6}		
Mo								.001		.0019
CaO		509.7	509.7	509	28.5	480.5		28.5		
Na_2CO_3										
TOTAL	2938	647.8	3137.8	3133.8	175.33	2958.4	11.28	190	613.4	519.4

TABLE 6-3 (Cont.)

FLOWS IN LBS/HR

	J	K	L	M	N	O	P	Q	R	S	T	U
Ca	224		13.11				.3			.3		224
Mg	7.5		4.4				.1			.1		75
Na	235.3		29.7	16.9			.29			.29		235.3
NH_3			.051	.051								
SO_4	1276.1		108.2	65.2			.95			.95		1276.1
Cl	55.45		2.4	.3			.04			.04		55.45
HCO_3	621.9	13.5	13.5		24.32		22	87.76		.84		635.4
CO_2	1.9		11.28		18.9	19.6	.7		81.2	.7		1.9
SiO_2	57.55		3.4				.05			.05		57.55
PO_4	.081		.081	.081								.081
Suspended Solids								229.4				
Cl_2	-2.44											
Alum				.49	.49		.49	47.9				

TABLE 6-3 (Cont.)

FLOWS IN LBS/HR

	J	K	L	M	N	O	P	Q	R	S	T	U
Polyelectrolyte				.051	.051		.051	2.04				
FC	.0093		.108	.091			.0013			.0013		.092
Cu	.166		.024	.022			3×10^{-5}			3×10^{-5}		.165
Zn	.053		.01	.01								.053
Sn	.0018		.0003	.0003								.0018
Cr	.002		.0008	.0008								.005
Ni	.00045		.00025	.00005			3×10^{-6}			3×10^{-6}		.00045
Mn	1×10^{-6}		1×10^{-6}	1×10^{-6}								1×10^{-6}
Mo	.0029		.001	.001								.003
CaO	538.1		28.5				.7			.7	29.1	538.1
Na_2CO_3	108										108	108
TOTAL	3191.2	13.5	219.7	83.25	43.74	19.6	25.7	367.1	81.2	4.0	137.1	3207.2

service life, and that gradually the load factor would be decreased to a minimum, with a lifetime average of 55% to 60% (FPC 1968).

After an initial break-in period, the load factor for Units 3 and 4 is expected to be 80%, and it should stay around this level until the successful break-in of the next base load units. Historical load factor data from utilities indicate that this value of load factor may be optimistic for the length of time considered. Further reductions would take place as other new sources come on line in the future and are cheaper to run. These other sources could be nuclear as well as coal.

If two prospective hydro projects, Buffalo Rapids and Mountain Sheep-Pleasant Valley, are constructed, the combined output for MPC would be about 500 MW, but at a low load factor of about 40%. Therefore, the project would be well adapted to accommodating changes in load, but would have minimal effect on the load factor of the Colstrip units. If no more hydro construction is authorized by the federal government, then gas turbine peaking units or expansion of existing hydro plants might be necessary to complement the large steam-electric plants which would provide the bulk of the new energy for the system.

A rough projection of the load factor for Colstrip Units 3 and 4 as submitted by MPC is that it will be quite high, around 80%, for the first eight to ten years. The load factor will then fairly consistently decrease to about 40% by the year 2015. The average lifetime load factor is planned for 65%.

The crew size for operating and maintaining Units 3 and 4 is expected to peak in July of 1979 with a total of 92 men. This value may be low, but only time and experience will reveal the actual number. This value should not decrease, as most of the operating personnel are needed to cycle the units for peaking purposes when they get older. Also, as the units get older, more men may be required on the maintenance crew for outages and repairs.

CHAPTER SEVEN Coal Mining Activities

Western Energy Company, a wholly owned subsidiary of MPC, operates the Rosebud Mine which would supply the coal to fire Units 3 and 4 if built. The Rosebud Mine was established in 1924 to supply steam locomotives on the Northern Pacific Railroad. Western Energy bought the town of Colstrip, mining equipment, and leases and renewed mining in 1968 after a decade of inactivity at the mine. Since 1968, this mine has supplied MPC's 180 MW Corette plant in Billings and some eastern utilities. By 1972, annual production was up to 5.5 million tons.

All production from this mine has been from the Rosebud seam, the major coal bed in the Colstrip area. The mined portion of this bed is a small portion of the total resource (Figure 7-1). Lying about 18 feet below the Rosebud bed is the McKay seam averaging about eight feet in thickness. Reserves in the Colstrip deposit total 1,439 million tons of strippable reserves (under less than 150 feet of overburden) (Matson and Blumer 1973).

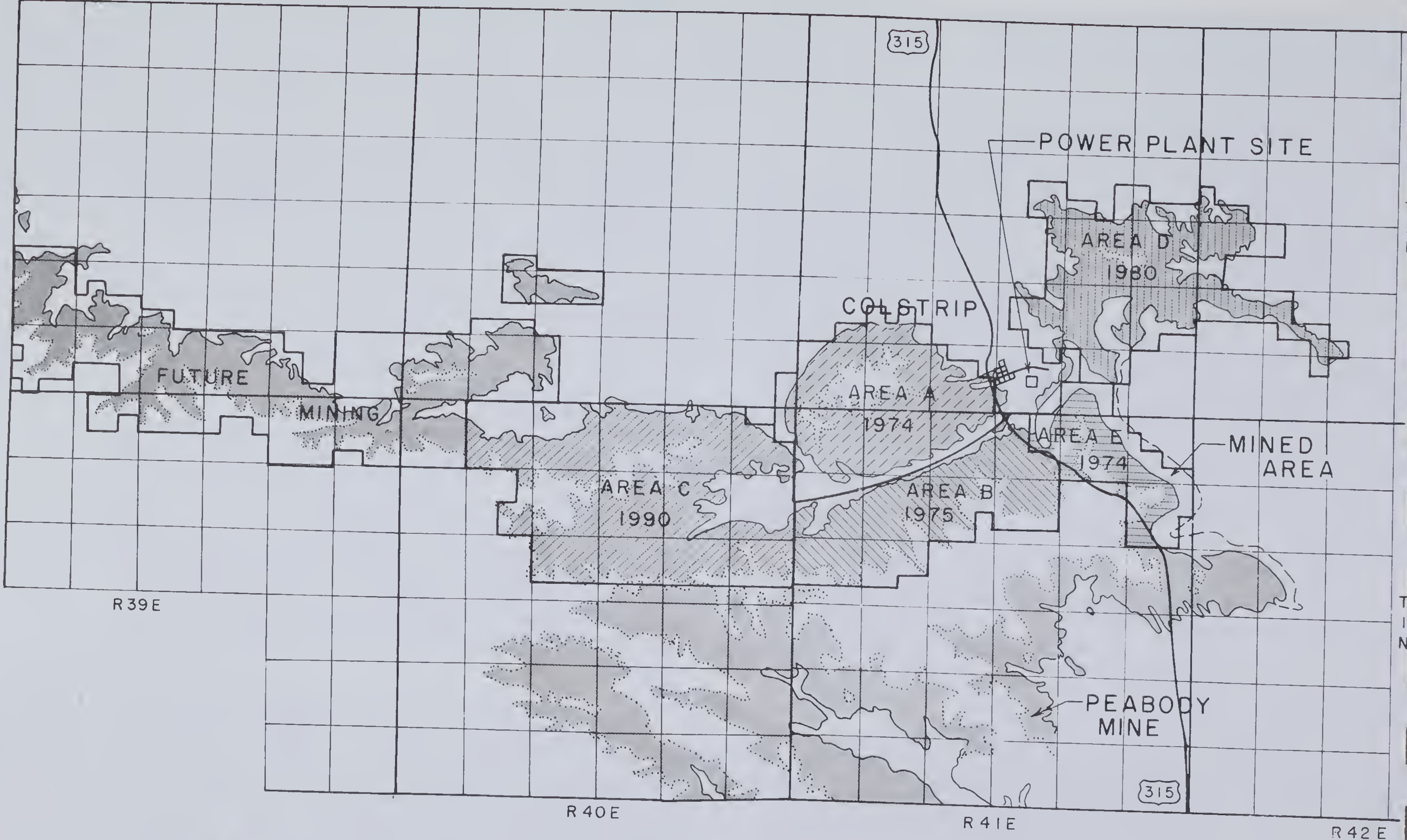
Present plans to exploit the coal deposit involve substantial expansion of the mine. Figure 7-1 shows the five areas (A through E) that would ultimately be mined. Areas C, D, and E would provide the coal to fire the four units of the Colstrip power plant if built. The sizes of these three mining areas are:

1)	Area C	7,680 acres
2)	Area D	2,689 acres, and
3)	Area E	723 acres
	TOTAL	11,092 acres

The three areas contain an estimated 573 million tons of strippable coal. Area E was planned to be mined beginning in 1974, Area D in 1983, and Area C in 1990. The company has no plans to mine the McKay coal.

The coal is obtained exclusively by surface mining or "stripping". Although several surface mining methods are employed in different parts of the nation, the method used at the Rosebud mine is known as "area strip mining". Unlike deep or underground mining, where the equipment and men operate under the strata which overlie the coal (overburden), in stripping these strata are physically removed to reach the coal. Surface mining is restricted to coal which lies at shallow depths. The depth at which coal can be economically stripped depends upon the size of the equipment, the quality and thickness of the coal, and other aspects of the local geology. At present, suitable coal under less than 150 feet of overburden is considered strippable. As technology increases, this limit also will probably increase.

The mining operation begins by digging a trench or box cut through the overburden to the top of the coal. The removal of the overburden is accomplished by a power shovel or dragline. The trench, which is considerably longer than it is wide, is oriented perpendicular to the direction of mining. Overburden from the first trench is piled on the side of the cut away from the direction of future cuts, resulting in a long pile standing well above the original ground surface and parallel to the trench. When the coal is exposed and the remnant overburden removed, the coal is removed by another shovel, loaders,



COLSTRIP COAL DEPOSIT—ROSEBUD SEAM
(MATSON & BLUMER 1973)

∿∿ - Limit of Rosebud
⋯ - 150 Ft. Overburden Limit

FIGURE 7-1

or other equipment and transported from the mine by trucks in this case.

Once the operation is underway, stripping of overburden and coal removal occur concurrently but in different parts of the mine. After the coal is removed from the first trench, a second trench is made adjacent and parallel to the first and on the side in the direction the mining is proceeding. The overburden of the second trench is piled into the first opening. This operation generally continues until the overburden becomes too thick or the coal is exhausted.

Prior to reclamation requirements upon the mining process, the mining ended with the above operations. The land was left with an unfilled trench and cliff (highwall) along one side of the mined area, a long, high pile of overburden along the other side (from the original cut), and a series of rough, steep ridges (spoil piles) between. Most of the surface would be at or near the angle of repose, and soil would be non-existent. Portions of the Rosebud mine, mined prior to reclamation laws, have been in this condition for decades; however, attempts are being made to reclaim these areas.

Recent reclamation laws have modified the basic mining operation in order to return the land to a productive condition. To achieve proper reclamation, the environmental setting and circumstances must first be considered. The mining plan is then built around the reclamation requirements so that mining and reclamation become inseparable. Reclamation is not an after-the-fact process to heal the wounds of surface mining.

The basic requirements of reclamation under Montana law and regulations include:

1) Salvage of the top soil,
2) Reduction of the slope of the spoil piles,
3) Reduction of the highwall,
4) Replacement of the topsoil,
5) Establishment of a vegetative cover,
6) Prevention of certain kinds of materials from being left at the surface,
7) Prohibition of mining where reclamation cannot be accomplished, and,
8) Approval of the mining and reclamation plans by the state prior to mining.

The varied requirements of the geology, topography, and reclamation make each portion of the mine unique. Although the basic process is followed, many particulars vary.

Surface mining of the intended magnitude would be necessary to supply fuel to operate Units 3 and 4 unless the fuel is mined elsewhere and transported to Colstrip. If the coal is derived from other deposits, the mining impacts are transferred geographically, but not eliminated. Underground mining of the Rosebud seam is not a viable alternative at Colstrip. However, if Units 3 and 4 are not built, the coal mining may still proceed more or less as planned to supply power plants elsewhere.

CHAPTER EIGHT Power Plant Study Area Inventory and Impact Analysis

8.1. Natural Environment

8.1.1. Meteorology

8.1.1.1. Climate

The climate of the study area reflects continental characteristics. Surface humidity is low. Precipitation is light but variable, and is confined primarily to the warmer seasons of the year. Daily temperature variations are large, and temperature extremes are pronounced. Prevailing wind speeds are moderate.

8.1.1.2. Air Quality

A. Existing Colstrip Air Quality

The Air Quality Bureau of the Montana Department of Health and Environmental Sciences (HES) has conducted monitoring in the Colstrip region designed to assess the existing ambient air quality. The pollutants monitored include sulfur dioxide, oxides of nitrogen, ozone, carbon monoxide, flouride, particulates, and trace elements. Measurements of various meteorological parameters such as ultra violet radiation, photosynthetic active radiation, visibility, relative humidity, temperature, and wind speed and direction were also made. The results of the pollutant sampling indicate that the Colstrip region is now typical of a rural, nonpolluted environment. Selected background results obtained at one site are summarized in Table 8-1. Table 8-2 contains the state and federal ambient air standards.

B. Air Pollution Potential

Air pollution potential is directly related to the ability of the atmosphere to dilute and disperse pollutants. When dilution and dispersion ability is limited, air pollution potential will be high. Dilution and dispersion ability is a function of three parameters: wind, atmospheric stability, and mixing depth.

Wind acts in two primary modes in pollutant dispersal. The mean wind transports pollutants from the location of the source, and the turbulent wind fluctuations mix the pollutants with the surrounding environmental air. In general, higher wind speeds and greater turbulent wind fluctuations promote greater dilution and dispersal.

Atmospheric stability is defined in terms of vertical atmospheric temperature structure. Stable conditions will suppress turbulence and hence pollutant dilution, while unstable conditions will promote the opposite effect.

Mixing depth defines the vertical extent of the volume of air available for pollutant dilution. Lower mixing depths generally mean less dilution and higher pollution potential.

Meteorological data relating to air pollution potential were collected at Colstrip during a one-year study by Montana State University

TABLE 8-1

SELECTED BACKGROUND POLLUTANT CONCENTRATIONS
COLSTRIP, MONTANA McRAE SITE

micrograms/cubic meter
($\mu g/m^3$)

Pollutant	Measurement Method	Average Value (Arithmetic)	Maximum Value	No. of Samples	Sampling Period
Suspended Particulates	Hi-Vol	9 ug/m^{3a}	60 ug/m^3	71	Nov. 73-June 74
Settleables Particulates	Dustfall	3.4 $tons/mi^2$	7.7 $tons/mi^2$	5	Nov. 73-May 74
Sulfation Rate	Lead Plate	0.006 $\frac{mg}{100cm^2\text{-day}}$	0.030 $\frac{mg}{100cm^2\text{-day}}$	8	Nov. 73-June 74
Sulfur Dioxide	Gas Bubbler	0.0001 ppm	0.0010 $\frac{ppm}{24hr}$	204	Nov. 73-June 74
Nitrogen Dioxide	Gas Bubbler	0.0015 ppm	0.0050 $\frac{ppm}{24hr}$	204	Nov. 73-June 74
Fluoride	Na Formate Plates	0.01 $\frac{ug}{cm^2\text{-30days}}$	0.05 $\frac{ug}{cm^2\text{-30days}}$	8	Nov. 73-June 74
Fluoride	Ca Formate Papers	0.02 $\frac{ug}{cm^2\text{-30days}}$	0.09 $\frac{ug}{cm^2\text{-30days}}$	7	Nov. 73-June 74
Ozone	Continuous (Chemiluminescence)	0.03 ppm	0.08 ppm	3820 (184 days)	
Carbon Monoxide	Continuous (Infrared)	0.00 ppm	0.00 ppm	3218 (166 days)	Nov. 73-June 74

a. geometric mean

TABLE 8-2

AIR QUALITY STANDARDS

National Ambient Air Quality Standards

POLLUTANT	PRIMARY STANDARD	SECONDARY STANDARD
1. Sulfur Oxides	80 μg/m³ (0.03 ppm) annual arith. mean 365 μg/m³ (0.14 ppm) max 24 hr. conc. not to be exceeded more than once a year.	1300 μg/m³ (0.5 ppm) max 3 hr. conc. not to be exceeded more than once a year.
2. Particulate Matter	75 μg/m³ annual geom. mean 260 μg/m³ max 24 hr. conc. not to be exceeded more than once a year.	60 μg/m³ annual geom. mean,[1] 150 μg/m³ max 24 hr. conc. not to be exceeded more than once a year.
3. Carbon Monoxide	10,000 μg/m³ (9 ppm) max 8 hr. conc. not to be exceeded more than once a year.	Same as primary
	40,000 μg/m³ (35 ppm) max 1 hr. conc. not to be exceeded more than once a year.	Same as primary
4. Photo Chemical Oxidants (corrected for NO_2 and SO_2 interference)	160 μg/m³ (0.08 ppm) max 1 hr. conc. not to be exceeded more than once a year.	Same as primary

[1] To be used as guide in assessing State Implementation Plans.

TABLE 8-2 (cont.)

POLLUTANT	PRIMARY STANDARD	SECONDARY STANDARD
5. Hydrocarbons (corrected for CH_4)	160 µg/m³ (0.24 ppm) max 3 hr. conc. (6 to 9 a.m.) not to be exceeded more than once a year	Same as primary
6. Nitrogen Oxides (as Nitrogen Dioxide)	100 µg/m³ (0.05 ppm) annual arith. mean.	Same as primary

TABLE 8-2 (cont.)

Ambient Air Quality Standards - Montana

POLLUTANT	STANDARD				
	Annual	Month	24-hour	1/2 hour	1 hour
Particulate, $\mu g/m^3$	75 geometric mean (G.M.)	-	200 1% of time[2]	-	-
SO ppm	0.02 arithmetic mean (A.M.)	-	0.10 1%/3 months[2]	-	0.25 once/4 days[2]
, sulfation-mg SO_3/100 cm^2/day	0.25	0.50	-	-	-
, sulfate-$\mu g/m^3$	4	-	12-1% of time	-	-
H_2SO_4 $\mu g/m^3$	4	-	12-1% of time	-	30 1% of time[2]
H_2S, ppm	-	5.0	-	0.03 twice/5 days[2] 0.05 twice/year[2]	-
Pb, $\mu g/m^3$	-	5.0	-	-	-
Be, $\mu g/m^3$	-	0.01	-	-	-
Fl, total as HF - ppb	-	-	1	-	-
Fl, as F in forage, ppm w	35	-	-	-	-
, gaseous - $\mu g/cm^2$	-	-	-	-	-

---

[2] not to be exceeded more than

TABLE 8-2 (cont.)

New Source Performance Standards (NSPS) for Steam Generators

The Federal Clean Air Act mandated that the EPA from time to time establish standards of performance for a category of sources whose emissions the Administrator feels may cause or contribute significantly to endangerment of the public health or welfare. This "standard" must reflect "the degree of emission limitation achievable through the application of the best system of emission reduction which (taking into account the cost of achieving such reduction) the Administrator determines has been adequately demonstrated." On December 23, 1971, EPA promulgated standards of performance for fossil fuel-fired steam generators. The heat input rating, i.e., the heating value of the fuel introduced to the unit, must be greater than 250 million BTU per hour in order for the regulation to apply. This is equivalent to about a 25 megawatt plant. Any plants under construction or modification to existing plants after August 17, 1971, must conform to the limits shown below.

	Allowable Emissions		
	Fuel-Fired		
	Coal	Oil	Gas
Particulate, $\#/10^6$ BTU	0.10	0.10	0.10
Particulate, opacity	20%	20%	20%
Sulfur Dioxide, $\#/10^6$ BTU	1.20	0.80	--
Nitrogen Oxides, $\#/10^6$ BTU	0.70	0.30	0.20

TABLE 8-2 (cont.)

Emission Regulations - Montana

A. Fuel Combustion - Particulate Matter

10^6 BTU/hr Fuel Heat Input	#Particulate/10^6 BTU (1) Existing Source	(2) New Source
10	0.6	0.6
100	0.4	0.35
1,100	0.28	0.20
10,000	0.19	0.12

B. Fuel Combustion - Sulfur Compounds

Effective Date	Pollutant	Allowable Emissions
July 1, 1972	SO_2	1.0 #S/10^6 BTU
July 1, 1971	H_2S	50 grains/100 ft^3

C. Visible Emissions

Existing Source	40 percent opacity
New Source	10 percent opacity

---

(1) Interpolate between values

(2) After November 23, 1968

(MSU). Part of the study consisted of relating the Colstrip data to similar observations for the sampled year taken at surrounding weather stations for which long term climatological records were available. The results of this comparison indicated that the sampled year was typical of the longer term climatology at Colstrip. The annual mean 307 foot above ground wind speed was 5.4 m/sec (10.8 mi/hr), and the predominant wind directions were westerly and northwesterly. Calm conditions (wind speeds from 0 to 2 miles per hour) occurred infrequently, about 3% of the time on an annual basis. The MSU catagorization method indicated that stable conditions (Pasquill stability classes E, F, and G) were frequent in all seasons and annually occurred about 60% of the time. Ground based inversions and/or isothermal layers existed at Colstrip almost daily during near dawn hours. The seasonal mean afternoon mixing depths calculated from MSU data varied from 400 meters (m) in winter to 2,800 m in summer, and the annual value was 1,300 m.

The existence of the ground based inversion and/or isothermal layers in the near dawn hours would tend to keep ground level pollutant concentrations due to elevated emission sources (such as the proposed Colstrip units' stacks) low while the layer exists. However, if the Colstrip stack plumes are initially contained within this layer, high ground level concentrations may result if the layer is eroded up to the plume height by surface heating. (This process is known as fumigation.) Preliminary calculations indicate that the Colstrip plumes may be contained within the near dawn inversion layer about 40% of the time, a situation that might lead to violations of short term state and federal sulfur dioxide standards.

C. Potential Cooling Tower Impacts

The function of cooling towers is to dissipate waste heat directly to the atmosphere. Wet cooling towers dissipate heat primarily by evaporating water and therefore act as sources of both heat and moisture. In dry cooling towers the cooling water is not directly exposed to the air, so only heat is emitted.

Although the meteorological consequences of the emission of heat and moisture from cooling towers are not well understood and generally cannot be quantified, several potential weather-related effects have been recognized. Cooling tower emissions from large power plants (1,000 MW and greater) may initiate cloud development, increase precipitation, enhance fog and icing, and create a visible plume. Also, suggestions have been made that cooling tower plumes may trigger severe weather.

Two other potential environmental effects of wet cooling towers are 1) the production of an acid mist, if the cooling tower and stack plumes mix, and 2) drift deposition. The latter term refers to the process in which a minute fraction of the water circulating in the cooling tower is broken into small droplets and carried out of the tower. These droplets may contain salts or chemicals which have been concentrated in the circulating water by evaporation.

Only a limited number of field and modeling studies have been reported which have attempted to evaluate these potential cooling tower impacts. A limited field investigation found that the plumes of a 244 m stack and of a 99 m natural draft cooling tower did mix under certain meteorological conditions, and sulfuric acid mist was produced by the mixing. Cloud growth models have been modified and applied to cooling tower plumes. Results of such applications tend to indicate that cooling towers will generally not have significant impact on cloud initiation and precipitation augmentation. Under certain meteorological conditions the cloud models have indicated that wet cooling towers and especially mechanical-draft towers may increase local fogging. How well the cloud models represent cooling tower plume behavior is unknown, as quantitative verifications of these models against actual field studies have not been reported. A similar situation exists with the prediction of drift deposition. Models have been developed, but are untested because of the lack of actual cooling tower data.

D. Modeling Analysis

To estimate the increased pollutant concentrations which would result from the proposed operation of Colstrip Units 1 through 4, three modeling approaches were used in conjunction with the meteorological and preliminary dispersion coefficient data collected by MSU at Colstrip. Two of the models used were Gaussian, while the third model was a dilution approach developed from the MSU diffusion study.

The dilution model is based on measurements of near ground level and ground level concentrations of ice nuclei (silver iodide, AgI), the tracer used in the diffusion study. By calculating the ratio of the measured ice nuclei concentrations to the ice nuclei emission rate, a dilution factor was developed which could be applied to the proposed stack emissions. The ground level concentration of a given pollutant could be calculated by multiplying the proposed emission rate by the dilution factor. Results of the dilution model indicated that only the 24-hour Montana sulfur dioxide standard might be approached by the proposed Colstrip operation. Only maximum criteria were used in developing the dilution factor so that dilution model estimates would be high. However, this approach is valid only for the meteorological conditions which existed while the ice nuclei concentrations were being measured. The maximum dilution concentrations may not represent the maximum possible concentrations for all meteorological conditions which occur at Colstrip. Also, the dilution model could only be used for short term averages (from one to 24 hours). Results of this approach are therefore not sufficient to predict whether or not standard violations would occur.

Annual and seasonal pollutant concentration estimates were made using a computer program of a Gaussian dispersion model supplied by the Environmental Protection Agency (EPA). This model is capable of utilizing long term wind, atmospheric stability, and mixing depth climatological data. The estimated maximum annual and seasonal concentrations of SO_2, NO_2, particulates, and flourides resulting from Colstrip Units 1 through 4 emissions contained in Table 8-3 were calculated, using the year of Colstrip data and the preliminary dispersion coefficient data collected by

TABLE 8-3

ESTIMATES OF MAXIMUM SEASONAL AND ANNUAL POLLUTANT CONCENTRATIONS: COLSTRIP UNITS 1-4 EMISSIONS

(in ug/m^3)*

	Annual	Spring	Summer	Fall	Winter
SO_2	28	30	38	31	91
NO_2	19	20	26	21	61
Particulates	1.4	1.5	1.9	1.6	1.7
Fluorides	$9x10^{-3}$	$9x10^{-3}$	$12x10^{-3}$	$10x10^{-3}$	$28x10^{-3}$

No seasonal ambient air standards exist. The applicable Montana and Federal annual ambient air standards in micrograms per cubic meter are:

	SO_2	NO_2	Particulates
Montana	52	--	75[a]
Federal	80	100	75[a]

a. Geometric mean

*The concentrations reported correspond to 1 atmosphere pressure and temperature of 298 K.

MSU. These values do not exceed the applicable Montana or federal annual ambient air standards. Figures 8-1 through 8-5 show the spacial distribution of the annual and seasonal sulfur dioxide concentrations in the Colstrip region projected to result from Units 1 through 4 emissions.

A Gaussian model was also used to estimate pollutant concentrations for one, three, and twenty-four hour averaging times. Unlike the dilution model, this model is theoretically capable of predicting concentrations for a wide range of meteorological conditions. Initial calculations using the preliminary Colstrip dispersion coefficient data developed by MSU indicate that the sulfur dioxide concentrations resulting from Colstrip Units 1 through 4 may exceed the Montana one hour and twenty-four hour and the federal three hour and twenty-four hour ambient air standards. However, on the basis of the existing data, the frequency of occurrence of those conditions for which the high concentrations were predicted is not known. Work is continuing at MSU to develop a better correlation between dispersion coefficient data and meteorological conditions so that frequency can be evaluated. Until this work is completed, the State can make no judgments as to the compliance or noncompliance of the proposed Colstrip units with existing short term ambient air standards.

E. Impact Assessment Specific to Colstrip

Verified methodologies necessary for quantitative assessments of known accuracy of the potential fog enhancement, drift deposition, visibility reduction, and acid mist production resulting from the proposed operation of Colstrip Units 1 through 4 are not available. Lacking such, only general qualitative assessments of some of these potential impacts are possible.

Any fog enhancement by the mechanical draft cooling towers probably would occur during the colder months, when the water vapor carrying capacity of the atmosphere is low, and only in the local vicinity (probably within a two to three mile radius) of the plant site. On those infrequent occasions when temperatures drop below about -30°C, ice fog may form as a result of cooling tower operation.

The expected drift rate of the Colstrip Units 1 through 4 cooling towers would be low (about 5.5 gallons per minute for Units 1 and 2 and 11 gallons per minute for Units 3 and 4). Because of a lack of actual cooling tower data and field verified drift deposition models, the validity of predictions of the amount of ground level deposition of chemicals originally present in the cooling tower water using existing models is not known.

Although the long term particulate emissions from Colstrip Units 1 through 4 are projected to be low on a mass concentration basis, the projected emissions would be primarily the small particles which scatter visible light most effectively. Also, some visibility reduction may occur during periods of high relative humidity due to the production of sulfuric acid mist droplets which scatter light. Some degradation of existing visibility at Colstrip would therefore occur as a result of the power plant operation.

If the cooling tower and stack plumes mix,

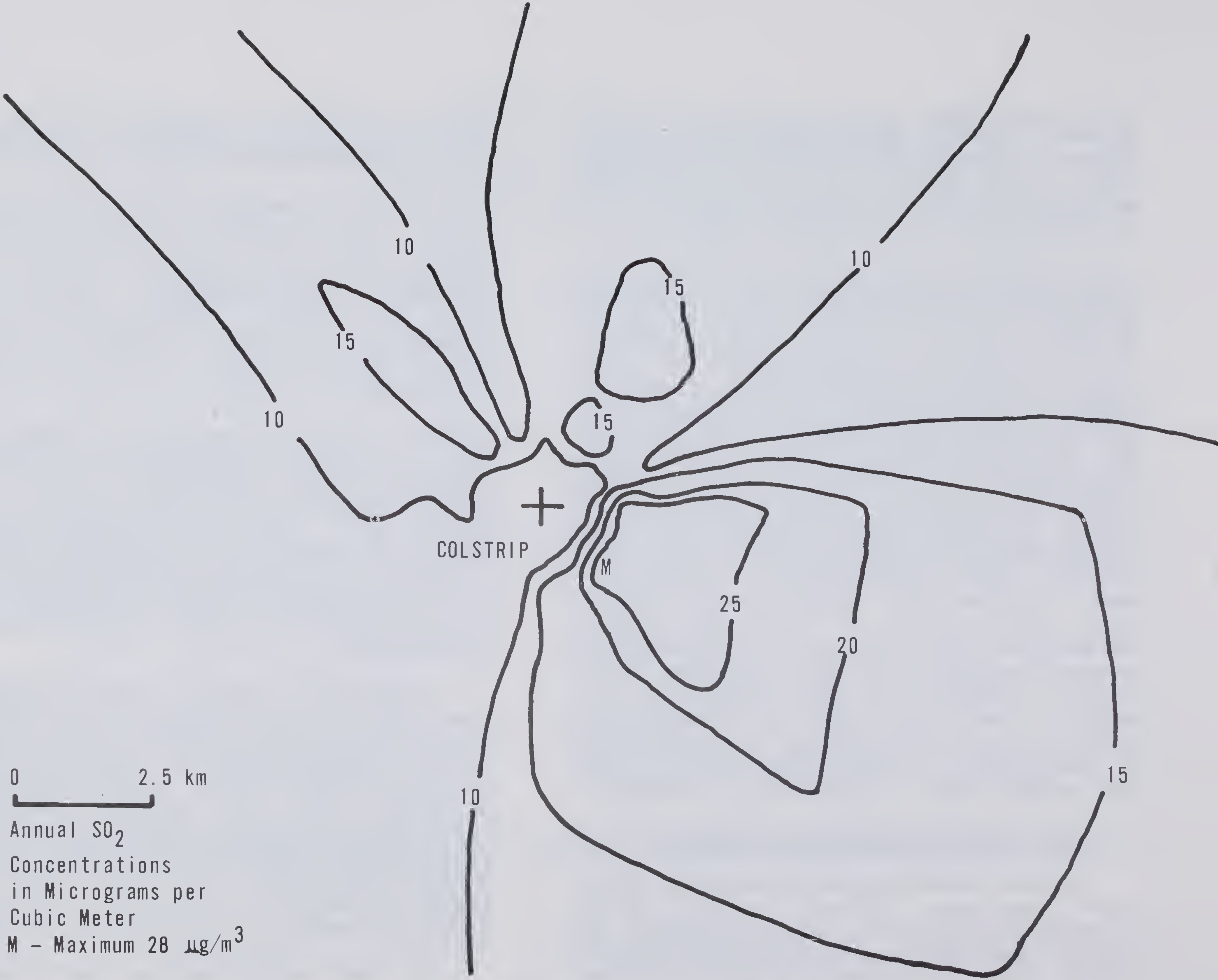

10
15
15
10
15
10
15
COLSTRIP
M
25
20
10
15
0
2.5 km
Annual SO_2
Concentrations
in Micrograms per
Cubic Meter
M – Maximum 28 μg/m^3

FIGURE 8-1

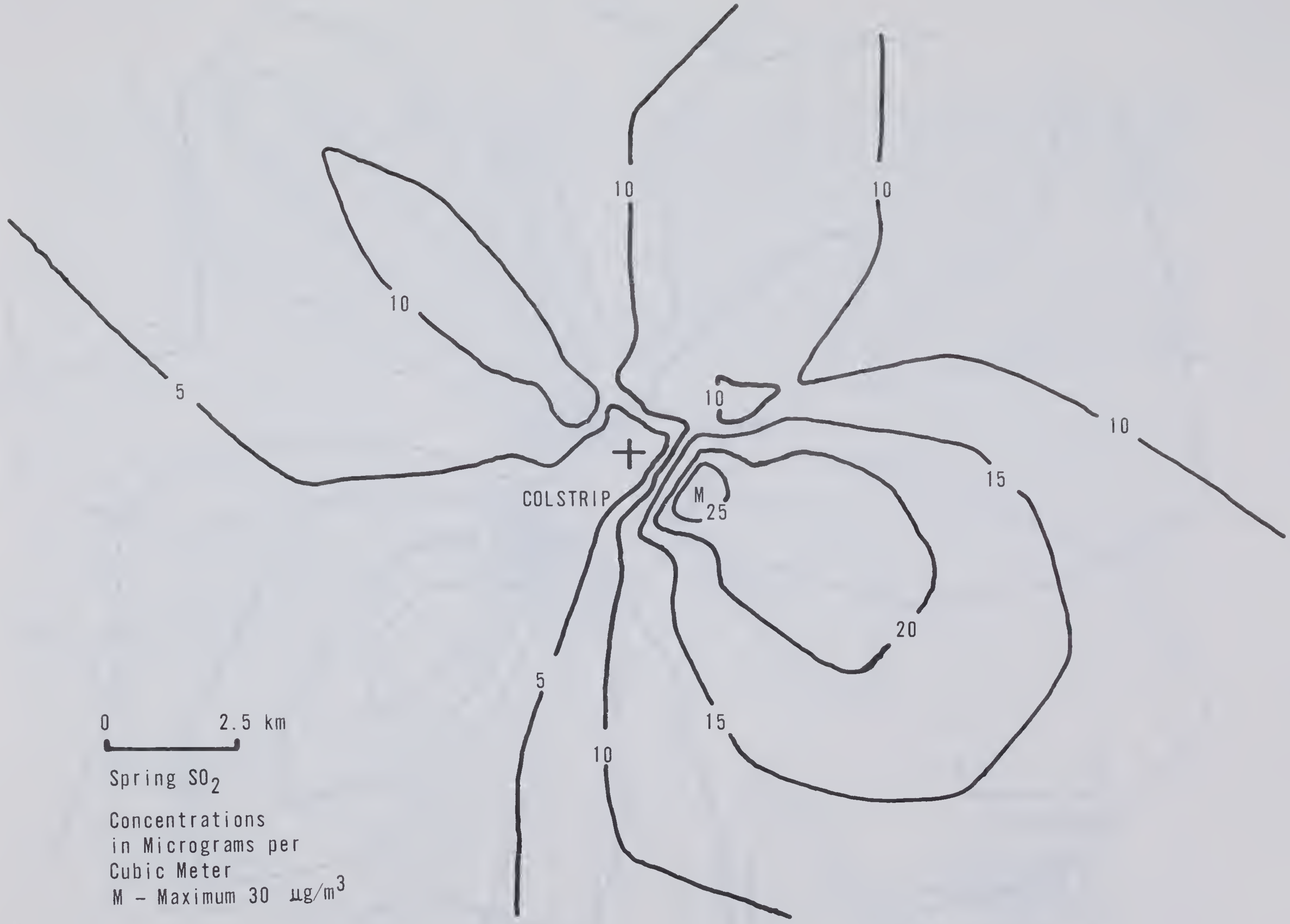
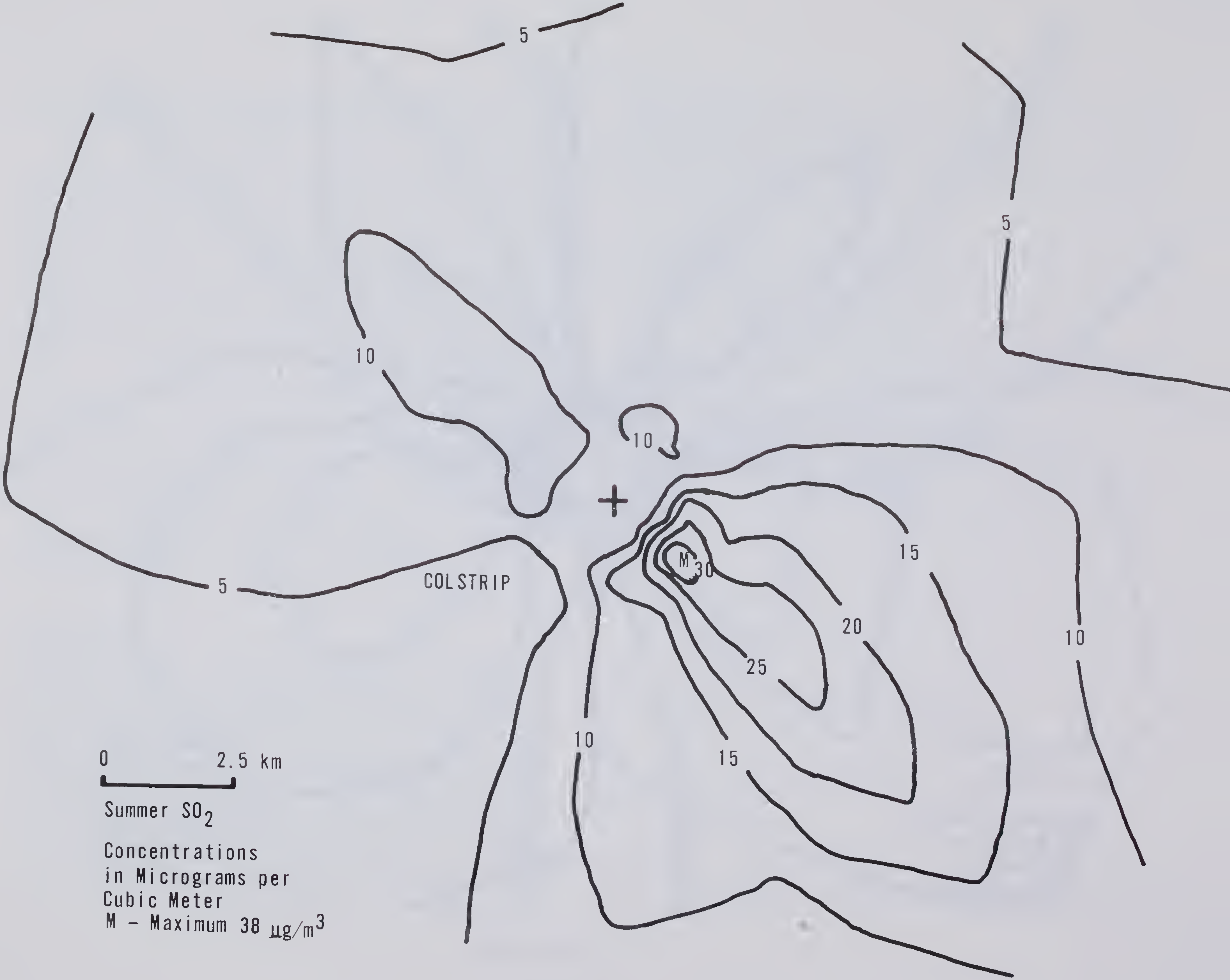

10
10
10
5
10
10
+
COLSTRIP
M
25
15
20
5
15
10
0
2.5 km
Spring SO_2
Concentrations
in Micrograms per
Cubic Meter
M - Maximum 30 $\mu g/m^3$

FIGURE 8-2



Summer SO_2

Concentrations
in Micrograms per
Cubic Meter
M – Maximum 38 μg/m^3

FIGURE 8-3

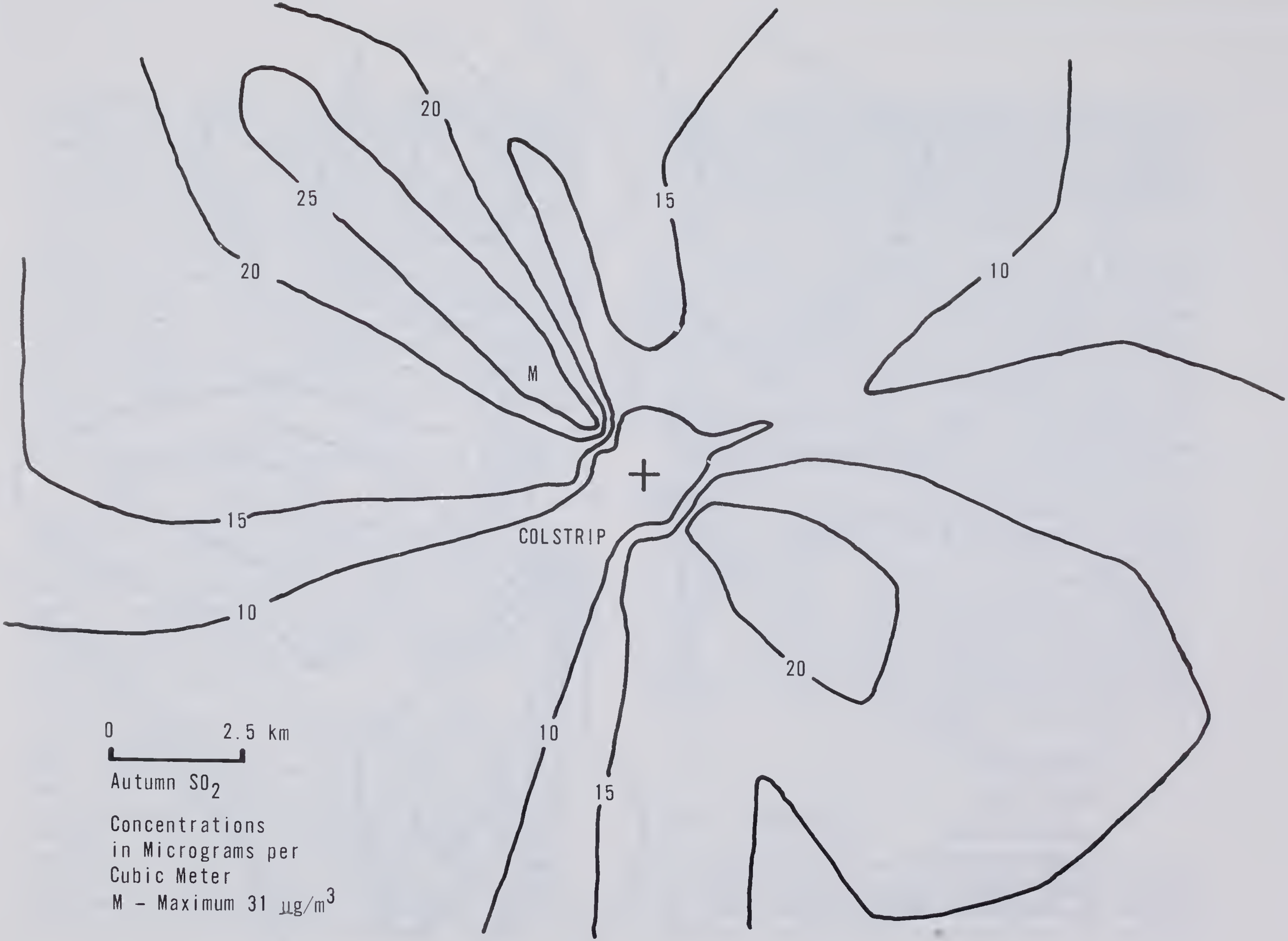

20
25
15
10
20
M
15
COLSTRIP
10
20
10
15
0
2.5 km
Autumn SO_2
Concentrations in Micrograms per Cubic Meter
M – Maximum 31 µg/m^3

FIGURE 8-4

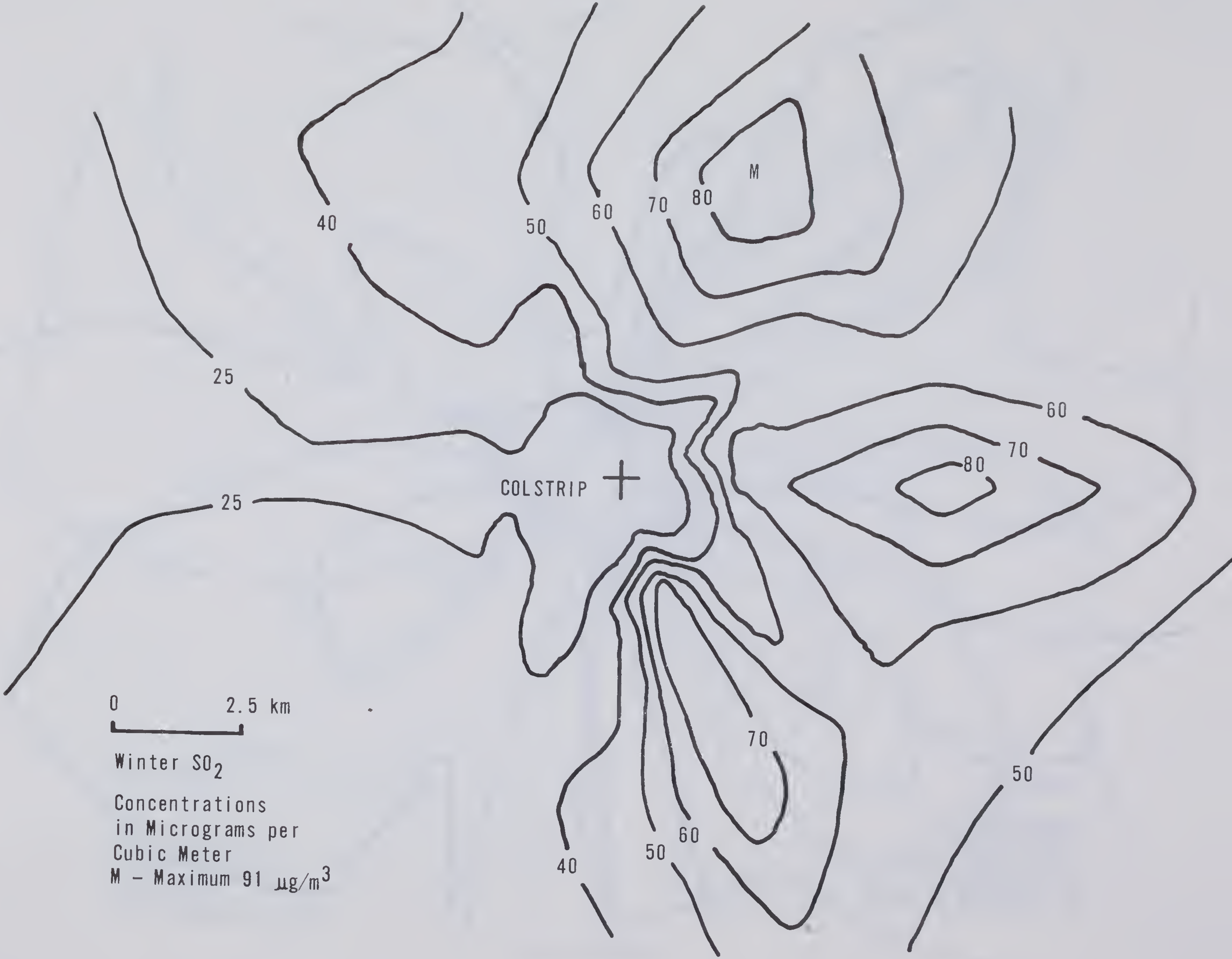

40
50
60
70
80
M
25
60
70
80
COLSTRIP
25
0
2.5 km
70
50
60
50
40
Winter SO_2
Concentrations
in Micrograms per
Cubic Meter
M – Maximum 91 µg/m^3

FIGURE 8-5

conditions favorable for the oxidation of sulfur dioxide to sulfuric acid mist would result. An analysis using existing plume rise techniques indicates that, under conditions of unlimited atmospheric mixing, complete co-mingling of the stack and cooling tower plumes would not occur. However, this prediction may not be true when an elevated temperature inversion or stable layer limits the vertical spreading of the stack and cooling tower plumes. Because the chemistry of stack plumes and mixtures of stack and cooling tower plumes is not well understood, predictions of the amount of sulfuric acid produced by a given amount of plume mixing must be considered speculation.

F. Adequacy of Particulate Ambient Air Standards

Federal and state ambient air standards are designed to protect the public health with a margin of safety and the public welfare against any known or anticipated adverse effects of air pollution. These standards reflect existing scientific knowledge of pollutant effects, the practicality of standard enforcement, and the social and economic costs of both the pollution and the control of the pollution.

One example of how existing standards reflect these practical considerations is the fact that they are written on an individual pollutant basis. Air pollution never consists entirely of one pollutant; rather, it normally consists of a mixture of many gaseous and particulate species, so that the effects of air pollution actually result from the complex interactions of many pollutants. The individual pollutant approach results largely from the limited understanding of these complex, multi-pollutant interactions and from the practical simplification of the air pollution problem which results from the individual approach. However, whether the total effects of air pollution can be obtained by a summation of individual effects is unknown.

Existing particulate ambient air standards may not be adequate with respect to the stated goal of protection of human health and welfare even on an individual pollutant basis. Current particulate standards are written on the basis of total weight of particulate matter per unit volume of air. However, the potential impact of suspended particulate matter on climate (including the heat balance of the earth-atmosphere system and cloud and precipitation initiation) on visibility, and on environmental health is related to both particle size and chemical composition, not merely total weight per unit volume. Particles in the 0.1 to 1 micron size range generally have a greater impact on these same parameters than does the equivalent weight of larger particles. Particulate emission sources, such as power plants, which meet existing total weight per unit volume standards but which emit significant amounts of submicron sized particles, still may have unacceptable environmental impacts.

8.1.2. Hydrology

Large scale coal mining and electrical generation at Colstrip could produce local, regional, and basin-wide impacts upon water supplies and water quality. Stack emissions could possibly influence surface water quality out to a distance of about 100 km (62 miles), primarily southeast due to prevailing winds. Water use could affect flows and quality of the Yellowstone River downstream from the intake. Ground water could be locally affected by strip mining and discharges from the power plants.

Many of the smaller tributaries of the Yellowstone River flow only during part of the year. Other streams show considerable variation in flow rates in daily, monthly, and yearly averages. Peak discharge for smaller streams at low elevations occurs from midwinter to early spring, whereas the major rivers have their maximum discharge in late spring and early summer as the snowpack at higher elevations melts.

The Yellowstone River, which drains the Colstrip area and nearly all of southeastern Montana, would supply water for the town of Colstrip and the generation units built there. The East Fork of Armells Creek passes through the town of Colstrip and drains much of the area which will be mined. Rosebud Creek drains the remainder of the area that would be disturbed by mining or construction of the associated facilities of the generating complex.

Local ground water systems occur in the aquifers of the Fort Union formation - mostly the sandstones and coal beds. The local ground water systems supply wells and springs in the Colstrip area which are used for domestic purposes and stock watering. Some deeper formations are aquifers which are part of much larger ground water systems. These aquifers are probably recharged largely in the Bighorn Mountains and the Black Hills of South Dakota.

8.1.2.1. Surface Water

A. Water Quantity

The percentage of decrease in the stream flow at two U.S. Geological Survey (USGS) stream gaging stations on the Yellowstone River as a result of the proposed maximum 59 cfs withdrawal for Units 1-4 is shown in the following tables. Low flows are historic low flows and may not be repeated, especially considering the regulatory capacity of Yellowtail Dam.

TABLE 8-4

PERCENTAGE OF FLOW DECREASE AT MILES CITY
USGS STA 06309000,
YELLOWSTONE RIVER AT MILES CITY, MONTANA

Base period 1929-1971

	Percentage of Decrease Due to 59 cfs Withdrawal
1 day mean low flow= 996 cfs	5.9
3 days mean low flow=1,032 cfs	5.7
7 days mean low flow=1,222 cfs	4.8
Mean annual flow=11,330 cfs	0.5
Highest recorded flow=96,300 cfs	0.06

TABLE 8-5

PERCENTAGE OF FLOW DECREASE AT SIDNEY
USGS STA 06329500
YELLOWSTONE RIVER AT SIDNEY, MONTANA

Base period 1929-1971

		Percentage of Decrease Due to 59 cfs Withdrawal
1 day mean low flow=	470 cfs	12.6
3 days mean low flow=	783 cfs	7.5
7 days mean low flow=	1,013 cfs	5.8
Mean annual flow =	13,030 cfs	0.5
Highest recorded flow=	159,000 cfs	0.04

For streamflows equal to 2,250 cfs at Miles City, a withdrawal of 59 cfs would result in a stage reduction in water surface elevation of 0.05 foot (0.6 inch).

B. Water Quality

The proposed power plants and the two power plants under construction will cause a variety of impacts on the area's water resources.

1. Local Impacts

a. Leaching of Solid Wastes

i. Coal Piles

Coal will be stockpiled at various locations awaiting feeding to the power plants. Storage piles will be compacted and will be surrounded by drainage ditches; Westinghouse (1973) states that water runoff from coal is not acid. Waters in the Colstrip area are in contract with in-place coal or coal-bearing wastes, and production of acid water has not been a problem. In view of the semi-arid climate and limited extent of coal piles, it is doubtful that these would have any impact on the area's water resources.

ii. Spoil Banks

Reclamation for strip-mined areas at the Western Energy Company mine near Colstrip will be conducted concurrently with mining. Runoff from the spoils will go through settling ponds via diversion ditches and, if necessary, be treated to avoid surface water pollution (Department of State Lands 1974). Since only a few tens of acres of spoils will be exposed and inflow and outflow are controlled, there should be little impact to surface waters from spoils runoff.

B. Potential Discharge from Water Storage Systems

i. Ash Pond

The ash pond would be sealed and would be designed to accommodate any runoff without overflowing (Westinghouse 1973). Since no outflows are anticipated, this facility should have no impact on surface water quality.

ii. Surge Pond

The surge pond will be about 150 acres in area. Since there is not expected to be any direct overflow from this pond to surface waters, no surface water quality impact should occur.

iii. Sewage Lagoons at Colstrip

The sewage disposal system for the community of Colstrip uses a three-cell lagoon. The population served by this system is about 2,000. Presently, there is no water in the third cell; thus, the system is not discharging. It is expected that there will be no discharge of sanitary wastes into surface waters in the area, and no adverse impact on surface waters is expected.

C. Cooling Tower Drift

One cooling tower would be used for each generating unit at Colstrip. Water will by pumped from the Yellowstone for the cooling towers, which will interact with hydrologic systems via drift. The drift will deposit an estimated 4.05 kg/sec (approximately 760 pounds per day) of solids (Westinghouse 1973). Deposition rates on the ground are estimated to be 0.5 to 0.7 lb/acre per month. These figures indicate that cooling tower drift would be a minor source of solids and should have little or no impact on water quality.

2. Regional Impacts

a. Stack Emissions

Particulates and gases emitted from stacks have been reported to create numerous water quality-related problems.

The quantity and the chemical and physical characteristics of constituents which would be emitted from the stacks of Units 3 and 4 have not been definitely established. The hydrolysis of certain components of stack gases in the atmosphere and prediction of distribution of particulates on the ground are difficult to quantify. Similarly, the dissolution of fallout and rainout from stack gases is poorly understood. The mechanism and rate of transport to water bodies and rate of mixing with water systems have not been investigated.

To appraise the effects of the 263 tons per day of sulfur dioxide planned emission from the four power generation plants, a comparison with similar plants can be made. The plants in East Helena emit an estimated 312 tons per day of sulfur dioxide, and the Anaconda Company in Anaconda emits about 1,030 tons per day of sulfur dioxide. Water quality investigations in the vicinity of these plants have not shown significant pH depressions in nearby streams. The alkalinity of waters in the Colstrip area is significantly higher than in waters near Helena and Anaconda. This comparison suggests that acid production from sulfur dioxide emitted from Colstrip Units 1,2,3, and 4 would not create significant pH changes in nearby streams.

To estimate the potential impact of lead, mercury, and fluoride on water systems, it was assumed that the elements were directly placed in streams. The rate of addition was assumed equal to the stack emission rate, and instantaneous and complete dissolution was assumed. Concentrations calculated from this extreme condition are still very low. There appears to be no reason to assume that adverse concentrations of these elements will occur in streams in the area.

b. Impacts from Point and Non-Point Sources Due to Population Increases

Development at Colstrip will result in large population increases in southeastern Montana and will generate additional sewage treatment needs. In addition to municipal wastewater treatment problems, a variety of non-point pollution problems could arise from various types of ground distrubances such as housing, road, and plant construction.

With an increased number of people and vehicles, an increase in the number of "accidents" or inadvertent spills of toxic or deleterious materials into streams (or underground water systems) will occur.

3. Yellowstone Dewatering Effects on Water Quality

Diversion of water from the Yellowstone River at Colstrip will cause a degradation of water quality downstream from the diversion, due to the decreased diluting capacity and increased temperature of the river. The decline in water quality, however, is expected to be slight.

8.1.2.2. Ground Water

A. Leaching from Waste Disposal Systems

1. Ash Pond

The proposed ash pond would be sealed (Westinghouse 1973), and if this sealing is effective, there should be no ground water impact from this facility.

2. Surge Pond

If the surge pond site has low seepage characteristics as reported by Westinghouse, inflow to ground water systems should be minor. General characteristics of the area, the surge pond water, and the geology suggest that the surge pond would cause no significant adverse impacts to ground water systems.

3. Septic Tanks

The number of housing developments will increase, some of which will not be connected to central sewer systems. This will result in increased use of septic tanks or seepage pits, which will degrade ground waters.

B. Alteration of Aquifers Due to Mining Activities

The impact of mining on aquifers is described in detail by Van Voast (1974). He states that the most obvious effect of mining will be the physical loss of wells and springs in the mined area. He further states:

Depending on the sizes of actual mine areas, as many as 19 wells and 3 springs can be physically destroyed during the mining operations. In addition, 4 wells will probably experience severe water-level declines and may become unusable. Five wells and 2 springs will probably experience moderate water-level and yield declines, possibly decreasing their seasonal usability. Three wells and 1 spring will experience slight water-level and yield declines.

Mine area C, due to the greatest density of wells in its vicinity and because of its upgradient position, will affect the most wells (19) and springs (3). Mine area B will affect 6 wells and 2 springs; area A will affect 4 wells; area D will affect 2 wells; area E will affect 1 well.

Hydrologic conditions in affected areas will adjust after mining is completed until a post-mining dynamic equilibrium is reached.

C. Leaching from Spoil Banks

After mining, the spoils may be leached by waters percolating downward. These waters may originate as precipitation on the spoils or as infiltrated irrigation water. Minerals leaching from the spoils may result in moderate to high concentrations of minerals in ground water (Van Voast 1974). The impact of this leaching depends on the volume of water infiltrating the spoils, dissolution processes in the spoils, and the quantity and quality of natural ground water entering the spoils. The summary of this discussion is that ground water quality impacts due to spoil bank leaching cannot be quantitatively predicted. It appears that one result of mining may be a degradation of water quality in selected aquifers down-gradient from the mined area.

8.1.3. Geology

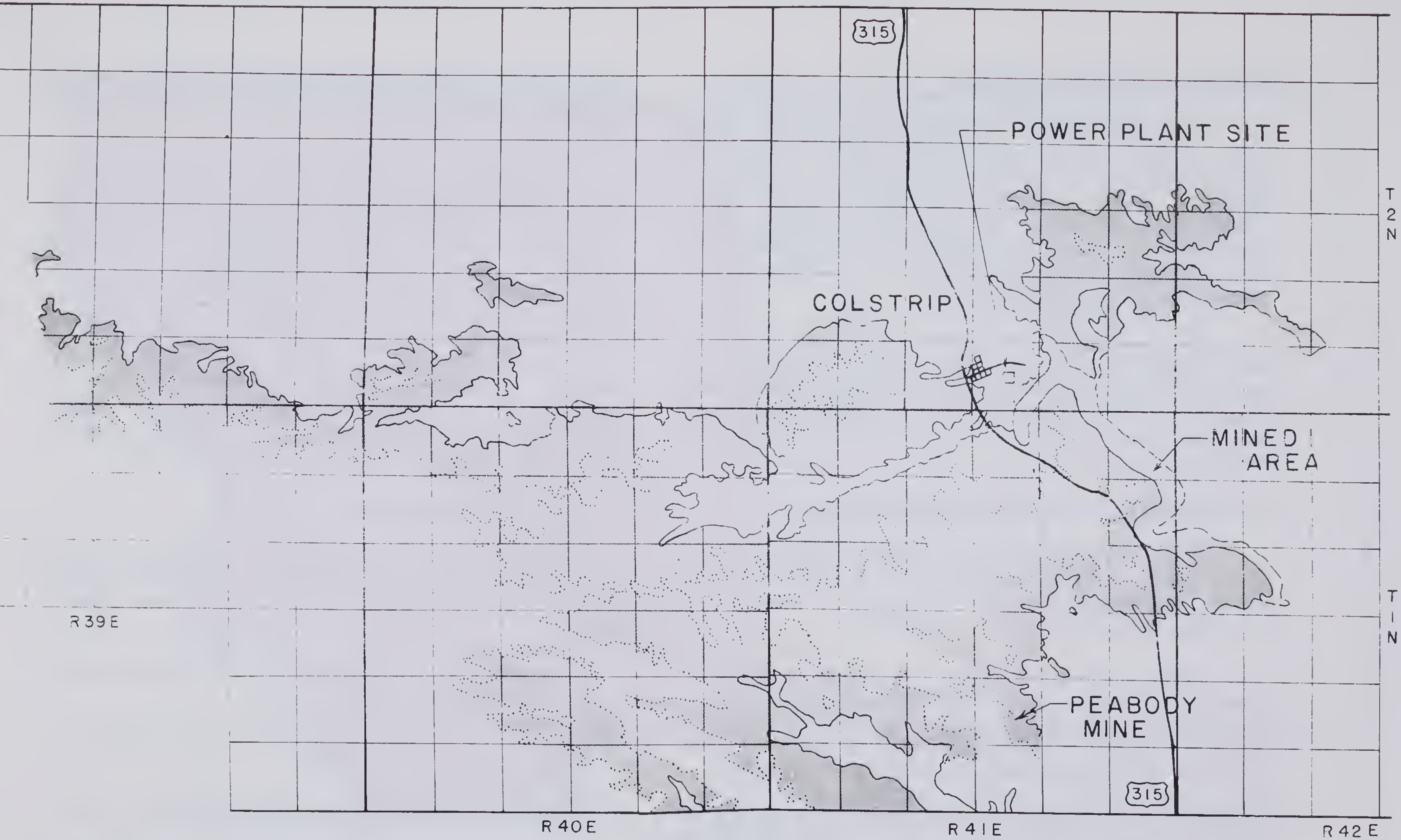
8.1.3.1. Plant Site

The proposed power plant site lies about 3,240 feet above sea level. Construction activity and trailer parks associated with Units 1 and 2 have greatly altered the natural appearance of the area and surroundings.

The plant site lies outside of but adjacent to the area originally underlain by Rosebud coal. The lower McKay seam does lie under the site and will be removed from immediately under the plant. The Rosebud seam has been mined as shown on the following figure.

Low rounded hills of sandstone and clinker surround the site. Local relief seldom exceeds 300 feet. Three miles south of Colstrip, some flat-topped hills reach an elevation of 3,640 feet. The highest elevations near Colstrip, about 4,800 feet, are in the Little Wolf Mountains, 15 miles to the west.

The East Fork of Armell's Creek flows through the edge of Colstrip at an elevation of about 3,220 feet. Rather than being a well defined floodplain, this valley is not a prominent landscape feature.



COLSTRIP COAL DEPOSIT—ROSEBUD SEAM
(MATSON & BLUMER 1973)

〰 - Limit of Rosebud
⋯ - 150 Ft. Overburden Limit

8.1.3.2. Geologic Impacts

The interaction between the physical earth and man's activities is dominated by earth processes. There is greater potential for severe geologic impacts upon the plant than for power plant impacts upon the earth's geology. The destructive force of earthquakes, floods, volcanic eruptions, landslides, and other geologic phenomena are well known.

The geologic processes which man alters, both intentionally and inadvertently, often result in further modifying man's activities. For example, polluted ground water affects man's use of the water and the streams' biological communities.

A. Geologic Impacts Upon the Power Plant

Structural failures may result from a number of causes. Foundation failure is a common occurrence; however, proper engineering design can overcome this and similar hazards.

Large earthquakes can disable electrical generating plants by damaging the plant itself or its associated facilities. Therefore, seismic hazards should be evaluated and taken into consideration in the planning of the proposed facilities. Colstrip lies well outside of the intermountain seismic belt (See Figure 8-6). Although Colstrip and several other places in eastern Montana have been the location of earthquakes, only one (in northeastern Montana) was strong enough to cause damage (Crosby et al. 1973; Coffman and vonHake 1973). Large earthquakes occurring in western Montana, especially the Hebgen Lake event of 1959, have been felt, but no damage resulted from these shocks in the Colstrip area.

Therefore, although small local earthquakes and large distant ones may be felt near Colstrip, it seems unlikely that a destructive shock will occur. Even less likely is quake-caused ground breakage which would damage the plant. Also, the absence of nearby steep slopes or large bodies of water greatly reduces the danger of mass movement or flooding. The consolidated Tongue River rocks are not thixotropic or likely to amplify ground motion. Consequently, the proposed plant site is one having minimal earthquake hazard, and a properly engineered plant is unlikely to suffer earthquake damage during its projected life.

B. Geologic Environmental Impacts

Building and operating the proposed power plants would create certain environmental impacts which are geological in nature. These impacts are:

1) Possible contamination of surface water and ground water,

2) Alteration of aquifers due to mining activities,

3) Mining of non-renewable resources, and

4) Destruction of geological information and natural landscape.

The first two impacts are considered in Section 8.1.2.

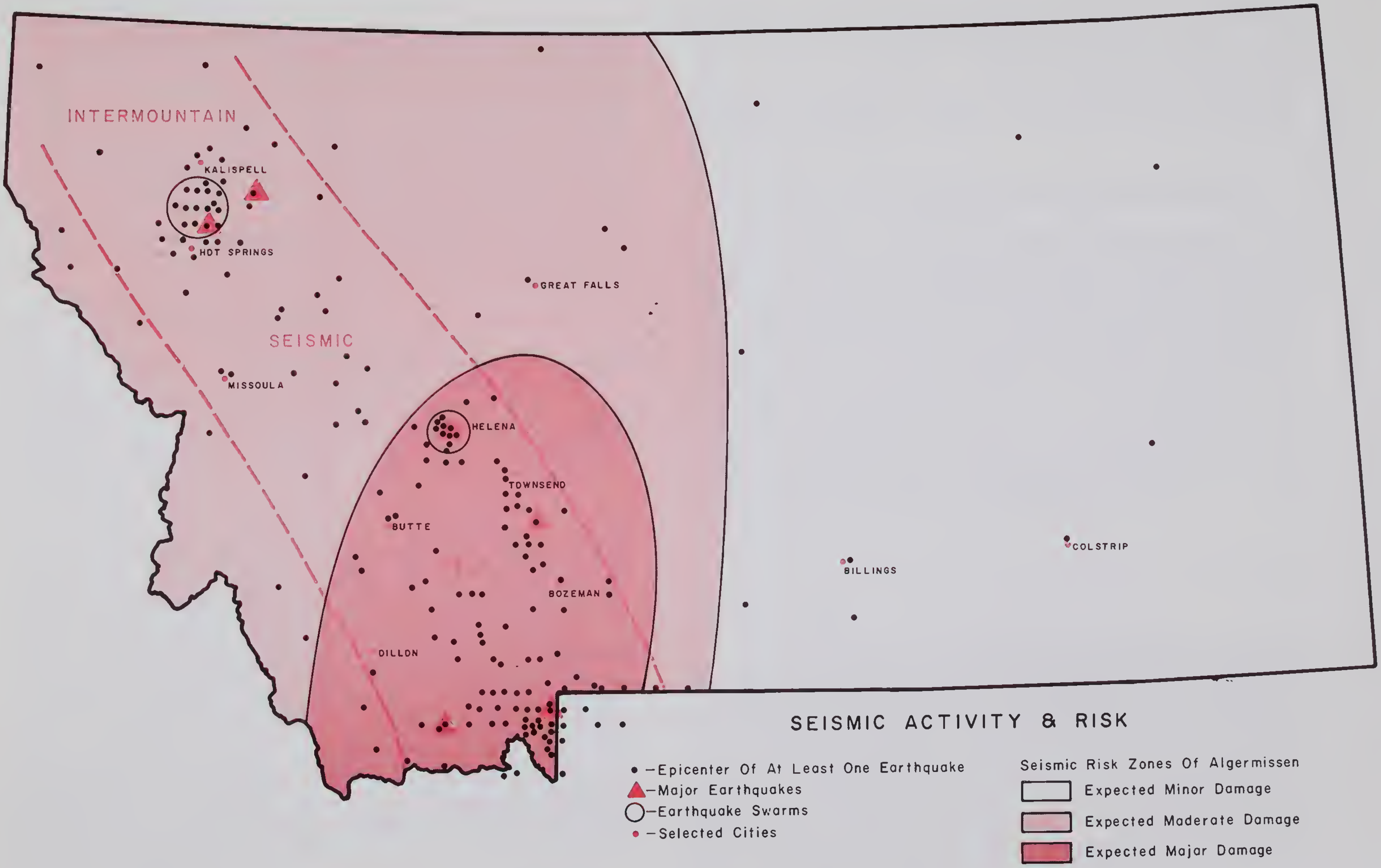

INTERMOUNTAIN
SEISMIC
KALISPELL
HOT SPRINGS
GREAT FALLS
MISSOULA
HELENA
TOWNSEND
BUTTE
BOZEMAN
DILLON
BILLINGS
COLSTRIP
SEISMIC ACTIVITY & RISK
• —Epicenter Of At Least One Earthquake
▲—Major Earthquakes
○—Earthquake Swarms
• —Selected Cities
Seismic Risk Zones Of Algermissen
Expected Minor Damage
Expected Moderate Damage
Expected Major Damage

FIGURE 8-6

1. Ash Disposal

Although the ash ponds and ash disposal sites have the greatest potential for geologic impacts, details concerning exact locations and construction methods were not available during the writing of this report. Potential environmental problems which might result from ash disposal can probably be eliminated by proper design and construction of the facilities once the geologic and engineering requirements are understood, but further investigations are necessary.

2. Non-Renewable Resources

Building the proposed Colstrip power plant would directly and indirectly consume vast amounts of non-renewable resources. Coal, iron, copper, aluminium, oil, natural gas, clay, limestone, sand and gravel, and many more earth resources would go into the plant.

Coal, for instance, is used to fire the boilers once the plant becomes operational, but coal is also used to make the steel that goes into the plant. Clay, limestone, and other materials are fired by coal, oil, or natural gas to make cement, which is mixed with sand and gravel to form concrete. Copper wire is the electrical conductor inside the generators and transformers, and other metals go into the stainless steel used in the boiler tubes. Also, numerous square miles of mines throughout the world would contribute resources to build the proposed plants, and 150 acres of southeastern Montana would be turned over to supply the fuel.

In addition to the environmental impacts created by mining, the use of these resources deprives future generations from using them. Since in most cases current mining is taking the best, most easily attainable resources, future mining will depend on more advanced technology in mineral recovery and/or obtain less with greater effort and cost.

3. Geologic Information and Natural Landscape

Although disturbed land surface may be regraded, the land morphology will be artificial. With the natural landscape gone, natural diversity and informational resources are also lost. All archeological material surficial geologic materials, and stratigraphic details of the overburden are irretrievably lost during strip mining. Within specific small areas, this loss seems small, but, when thousands of acres are disturbed, the informational resources which are lost and the aesthetic impacts add greatly to the environmental costs of the plant.

8.1.4. Soil

The impacts of emission and erosion cannot be assessed without an understanding of the soil characteristics of the landscape. The landform inventory technique used in this study, based on the Ecoclass System developed by the U.S. Forest Service (1973a), recognized that distribution of soils is determined by factors of climate, physiography, native vegetation, and the source of the parent material. The physiographic features of the study area were divided into four major units, which were than subdivided into various soil characteristics as follows:

Soils of the Mountains

1) Soils developing in material weathered from noncalcareous consolidated rocks other than granites on very steep or steep mountain slopes with significant outcroppings of rock.

2) Soils developing in material weathered from permeable limestone bedrocks on steep or very steep mountain slopes, with areas of rock outcroppings.

Soils of the Foothills

1) Soils developing in loamy material weathered from folded, consolidated sedimentary and basic igneous rocks on hilly to steep uplands and steep lower valley sideslopes.

Soils of the Plains

1) Soils developing in sandy to clayey material weathered from sandstones and shales on nearly level benches.

2) Soils developing in clayey material weathered from clay shales on undulating to steep uplands.

3) Soils developing in loamy to clayey material weathered from shales on steep to very steep, highly dissected badlands.

5) Soils developing in clayey and loamy material weathered from interbedded unconsolidated and consolidated sediments on well dissected uplands, narrow level ridgetops, and steep valley sideslopes.

6) Soils developing on clayey material weathered from interbedded, steeply dipping, consolidated and unconsolidated sedimentary rocks.

Soils of the Alluvial Lands (Floodplains)

1) Soils developing in highly stratified alluvial deposits on stream floodplains and low terraces.

The possible impacts of the proposed Colstrip Units 3 and 4 on the soils in the study area are of three general categories: impacts on the soils due to the actual construction and maintenance of the power plants, possible impacts on the soil due to emissions of pollutants after the plants are in operation, and impacts due to mining of coal for the plants. Other land uses directly related to soil capabilities, especially agricultural, would be precluded by the physical presence of the power plants, but this impact is not considered significant because of the small amount of land involved.

The actual area of construction of the power plant will remove land from production of native range grasses. Also, the soil will be altered as to pH, texture, structure, and other related characteristics. However, the actual acreage disturbed is not large when considered in terms of the entire study area.

The sedimentation of Armells Creek will be affected very slightly due to construction and building sites creating more bare ground. However, the overall watershed must be considered with its steep escarpments and areas of bare ground. The large area of spoil banks from the coal mines, the town of Colstrip, bare stream bottoms, highway and railroad rights-of-way, and a few acres of dryland grain and bare summer fallow all add their share of sediment when it rains. The sediment coming from the plant site and pipeline areas during construction would not be enough to be considered a prime cause of pollution of Armells Creek, but any bare ground, loosely packed pipeline trenches, etc., should be planted with a cover crop as soon as possible after construction. Topsoiling will be necessary because the high-lime C horizon will generally end up on the surface, and grasses and some legumes do not germinate properly on high-lime soils.

The compaction due to construction will also retard intake of moisture and rooting of plants. Thus, ripping of compacted areas and correct preparation of seed bed is necessary for proper reclamation.

The major impact upon the soils may be the chemical emissions from the power plant units. There is a strong possibility that acid rain may change the soil pH and that emitted heavy metals may accumulate in the soil and subsequently be taken up by vegetation root systems at toxic levels. However, these impacts are very difficult to analyze at this time because of limited research. With chemical baseline data established for the Colstrip area, such studies will be possible when Units 1 and 2 come on line.

The pollutants which will be emitted from the plant (sulfur dioxide, nitrogen oxides, particulates, gaseous fluoride, solid fluoride, lead as monoxide, mercury etc.) will also appear in the ash ponds. Alteration of soil chemical composition levels is possible if seepage occurs from the ponds. Because the rate and concentration of the seepage, if any, and the rate of oxidation of the chemicals are not known, it is also impossible to predict the potential extent of alteration of the soil. However, if the applicants use sound construction techniques, seepage should not take place at the ponds.

8.1.5. Vegetation

8.1.5.1. Inventory

The study area has 16 vegetation types, which appear on the accompanying Vegetation Types Map.

Vegetation diversity within the study area results from a variety of topography, soils, climate, and past history of land use. Elevational and climatic gradients determine the kinds of vegetation that dominate. In the lower elevations and precipitation zones, riparian, sagebrush-grass, and grassland communities usually dominate. Coniferous forest and shrub communities usually dominate the higher elevations and precipitation zones.

Relict areas (areas of near-pristine

vegetation which can be used for study and comparison of presently existing vegetation against the potential of the site) are also shown on the Vegetation Types Map and include Melstone Cemetery, Custer Battlefield, Reno-Benteen Battlefield, Wagon Box Cemetery, Creek-Decock Ranch, Theony Cemetery, and the north slope of Pompey's Pillar.

Several plant species have been classified as noxious or poisonous, but neither classification presents a major problem in the study area.

A. Forest Resource

Forests in the study area are generally not as plentiful and do not achieve the tree size of forests in central and western Montana. Consequently, their value as a timber resource is overshadowed by their importance for watershed, recreation, aesthetics, and wildlife values.

The major tree species is ponderosa pine, sometimes occurring with Rocky Mountain juniper. Douglas fir is found toward the southern part of the study area, especially in the Big Horn Mountains, occurring with lodgepole pine and quaking aspen. Broadleaf trees occurring along rivers and streams include cottonwood, box elder, and green ash.

B. Range Resource

Rangeland within the study area is approximately 85% of the total land area. Livestock production, wildlife and recreational activities depend upon it. The range also is a watershed and is thus closely connected to effective water conservation and management.

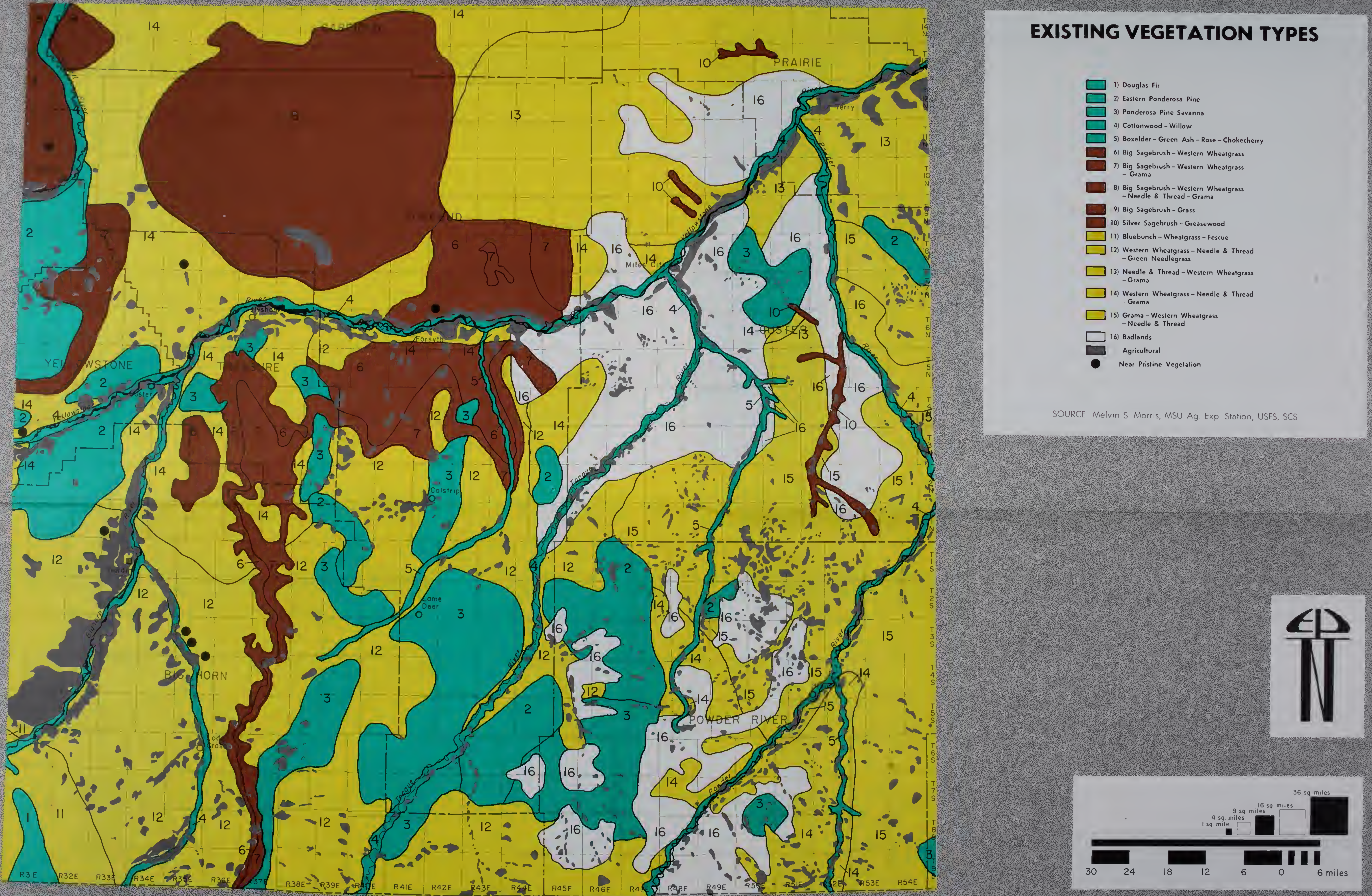
The five major geographic range types in the study area and their productive estimates (measured in acres/animal unit month) (Payne 1973) are as follows:

1)	Eastern ponderosa pine woodland types	3.5-4 A/AUM
2)	Foothills grassland types	3 A/AUM
3)	Central grassland types	3.5-7 A/AUM
4)	Badlands type	5.5 A/AUM
5)	Southeastern grassland types	3-4 A/AUM

Approximately 46% of the rangeland in the study area is in good to excellent condition; 54% is in less than good condition (Jackson 1973). The sections of the study area classified as eastern ponderosa pine savanna and woodland are in fair to good condition. The foothills grassland, predominantly the bluebunch wheatgrass-fescue type, is in excellent condition. The condition of the central grassland types and southeastern grassland types is relatively good. The badlands are in fair condition.

C. Vegetation Chemical Analysis

In order to assess the impacts on vegetation which would occur due to the emissions of power plant units at Colstrip, it is necessary to establish baseline levels of phytotoxins in vegetation of the Colstrip area. Phytotoxins studied



EXISTING VEGETATION TYPES

🟩 1) Douglas Fir
🟩 2) Eastern Ponderosa Pine
🟩 3) Ponderosa Pine Savanna
🟩 4) Cottonwood – Willow
🟩 5) Boxelder – Green Ash – Rose – Chokecherry
🟫 6) Big Sagebrush – Western Wheatgrass
🟫 7) Big Sagebrush – Western Wheatgrass – Grama
🟫 8) Big Sagebrush – Western Wheatgrass – Needle & Thread – Grama
🟫 9) Big Sagebrush – Grass
🟫 10) Silver Sagebrush – Greasewood
🟨 11) Bluebunch – Wheatgrass – Fescue
🟨 12) Western Wheatgrass – Needle & Thread – Green Needlegrass
🟨 13) Needle & Thread – Western Wheatgrass – Grama
🟨 14) Western Wheatgrass – Needle & Thread – Grama
🟨 15) Grama – Western Wheatgrass – Needle & Thread
☐ 16) Badlands
▨ Agricultural
● Near Pristine Vegetation

SOURCE Melvin S Morris, MSU Ag. Exp Station, USFS, SCS

include sulfur dioxide, nitrogen oxides, particulates, and fluoride.

1. Sampling

Vegetation samples were collected from 35 sites in the area surrounding Colstrip in two "sets", one in the fall of 1973 and the other in the spring of 1974.

Six major species of plants were chosen for chemical analysis: 1) skunkbrush, 2) big sagebrush, 3) Rocky Mountain juniper, 4) bluebunch wheatgrass, 5) little bluestem, and 6) ponderosa pine. These species were picked not only because they are prevalent throughout the area, but also because they are either faster accumulators of pollutants or are slow accumulators but manifest air pollution damage very rapidly.

Samples from all sites were analyzed for fluoride (F^-) content, and samples from some sites were also analyzed for sulfur (S) content.

2. Conclusions

The Colstrip study area is a superb "control" area for total S in ponderosa pine and for F^- in grasses, shrubs, and ponderosa pine. Further, both S and F^- increase in the vegetation of the area during the growing seasons, but decrease during the dormant period.

S.1.5.2. Impacts

A. Construction

1. Power Plants

The impact of construction of Units 3 and 4 would not be great. The plant site is presently a parking lot, so little vegetation would be lost in construction. However, new parking access areas and utility buildings would take further areas out of production. Soil compaction resulting from use of heavy equipment, and the land taken out of production by the presence of the plants themselves represent the primary impacts.

2. Pipeline

From the initial clearing and grubbing of the 60-foot right-of-way to the final clean-up phases, all vegetation within the right-of-way would be destroyed.

The eventual impact on the vegetation would depend on how the soil profile is replaced. Other factors influencing revegetation include slope, aspect, temperature, and animal activities. Species should be suitable to the areas on which they are to be planted. Equally important to consider is the purpose for which the species will be used, such as grazing, browse, or stabilization. In most instances, it is highly desirable to have a balance of shrubs, forbs, and grasses on a given site (Plummer 1970).

Plant succession on disturbed sites will be affected by the kind of plants adjacent to the site and the seed crop they are capable of producing. On exposed mineral soils, various pioneer plants will invade. For this part of Montana, these invaders will be annual fescues and bromes, and many other annual species including Canadian thistle, leafy spurge, Russian knapweed, and prickly pear (USDI 1973). Most invading species are highly competitive and do well on most sites.

Maintenance of the pipeline will create an access road the length of the line. If travel is restricted, the problem of disturbance will not be severe.

B. Emissions (General)

1. Acute and Chronic Damage to Vegetation

Two things which must be recognized are 1) the difference between acute and chronic types of vegetation air pollution damage, and 2) the phenomenon of species selection and adaptability of plants growing and surviving in areas where air pollution has occurred for long periods of time.

a. Acute Damage

Fumigation which causes acute foliar damage is a common-occurring phenomenon when large stationary emission sources first go on-line, unless the area has experienced long periods of previous fumigation.

One example of acute damage would be the serious plant damage, especially to conifers, in the Garrison area when the Rocky Mountain Phosphate plant went on-line in 1963. Vegetation damage was noticed in a one to seven-mile radius around the plant in a one to three-month period and six to ten months prior to acute or chronic damage to animals.

If acute fumigation damage occurs only occasionally, the plants usually recover normally, as they do after a serious, unseasonable freeze or drought episode. With annual species of plants, acute fumigation damage can have a more severe effect, since the total seed production in a given location could be destroyed if the fumigation occurred prior to or during pollen or early seed development.

In the Colstrip area, there has been continuous monitoring by personnel of the Department of Health and Environmental Sciences for various phytotoxic gases. The only one which seems to be present at continuously measurable levels is ozone, which averages 0.03 ppm, or 0.05 ppm below federal ambient air standards (0.08 ppm). The instant or initial shock damage phenomenon which occurs with the introduction of phytotoxic gases into a relatively clean or pristine area will first manifest itself in the form of acute necrotic damage on current-year needles of susceptible ponderosa pines growing on exposed ridges. This foliage, together with other perennial plant species such as shrubs and grasses growing on exposed ridges, will accumulate higher concentrations of fluoride and/or sulfur than will the same species growing on less exposed areas.

b. Chronic Damage

Chronic damage by air pollutants is that which is caused only after prolonged or intermittent periods of low level fumigation. An example of chronic vegetation damage in a seriously polluted area would be near Anaconda, Montana, where vegetation which has survived in a 15-mile surrounding area manifests leaf burn on foliage only at or towards the end of the growing season, even though 28 tons of SO_2 are released each hour from the copper smelter located there.

Chronic type plant damage is slow and insidious, and measurable differences are necessary to quantify plant responses at chronic fumigation levels.

2. Polluting Agents

a. Sulfur Dioxide

It has been known for many years that gaseous sulfur dioxide (SO_2) alone will damage plants. Scientists (Oden et al.) have established that SO_2 can remain in the atmosphere for two to four days and travel over 1,000 kilometers (600 miles) during residence time in the ambient air.

No other phytotoxic gas has received more study by the scientific community than SO_2. By far the largest portion of the U.S. literature on this subject deals with fumigation studies where known quantities of SO_2 are released for given periods of time into fumigation chambers filled with certain species of vegetation. Fumigation studies on the effects of SO_2 on plant species are unrealistic, since only one or two gases are used at a time and at given concentrations, with no peaking concentration or low periods.

Scientific papers on SO_2 and vegetation damage coming from Europe and Asia deal primarily with damage to indigenous plants and agricultural crops around large stationary sources. Unfortunately, while these articles adequately cover plant damage caused by SO_2 and other gases, they do not include ambient air levels of SO_2 or other gases, except at one or two locations, at best, in large areas of damaged vegetation.

i. Acid Rain

Sulfur dioxide can be oxidized to sulfuric acid in the atmosphere, and this acid may be brought to the ground on particles or by rain, called acid rains. The environmental problems and ecological consequences of acidic rains to the animate and inanimate portions of the earth are just starting (in the last 20 years) to be realized, and many fundamental questions concerning even the physical and chemical properties of acidic precipitation are yet unanswered.

However, for the purpose of this report, it should suffice to know that it is scientifically established that:

1) SO_2 will convert to SO_4 in the atmosphere,

2) SO_2 and SO_4 have the physical ability to be carried long distances from their emission sources,

3) SO_2 can be oxidized to sulfuric acid in the atmosphere and during precipitation washout can impact the physical and biological systems of the earth, and

4) Several studies have demonstrated that rain water which falls in the spring and summer is more acidic than rainfall in the winter months (Likens and Bormann 1974). This means that during the most susceptible period of

the plant's life cycle (early developing stages of vegetative and reproductive tissues), acidic rains are more prevalent than during the dormant periods of the plant's life cycle.

In general, however, most acid rain damage to plant tissues occurs over a long period of time (one growing season or more) and is insidious, thus making it more difficult to evaluate. Examples of this type of damage would be a reduction of the total crop weight from the previously "normal" crop weight -- in other words, a reduction in the biomass of the vegetation (food source) growing indigenously in an area or propagated by man. At present there is no scientific literature which demonstrates that acidic precipitation has caused a reduction of the biomass of any food crop propagated by man. Therefore, the only available data which deals with late detection of acid rain damage comes from studies on premature casting of conifer needle foliage of cultivated and indigenous species of pine.

From studies carried out by personnel of the University of Montana Environmental Studies laboratory as well as by Dr. Bormann's laboratory (1973), it has been established that inoculations of needle and leaf tissues with acid solutions at various pH levels will cause cellular and tissue damage. As can be ascertained from these data, a pH value in the range which has been shown to cause damage to the basal tissues of young emerging pine needles (pH 4.5 for H_2SO_4 and 5.5 for $HF \cdot H_2O$) will result in a very small concentration of these anions.

In rather severely air polluted areas in a 10 to 15-mile radius around the Anaconda copper smelter and the East Helena lead smelter, ponderosa pine retain two to three years of needle growth. At further distances (up to 30 miles away), three to four years of needle retention is not uncommon. However, four years is believed to be average for ponderosa pine.

The retention of a normal complement of needles by a coniferous tree is needed for the realization of normal food production and thus annual growth. As this retention is reduced, food production and annual growth are in turn reduced.

It is not known at what pH the precipitation has to be to cause this slow (one to three years) necrosis which leads to premature casting, but it obviously is above 4 to 4.5 pH, since these levels are known to cause needle dwarfing.

In the case of acidic precipitation, no other species of plant has been found to date which is damaged as visibly or severely as are several species of the genus pine. While it is possible that acidic precipitation may at even higher pH levels (going toward a pH of 7) cause damage to other living organisms, cause slow and insidious leaching of nutrients from the soils, or even cause lake waters to become acidic, there is no scientific evidence in the literature at this time to quantify or qualify that assumption.

3. Adequacy of Air Quality Standards

Important facts which come from a study of the Mt. Storm, West Virginia, area (Gordon 1972) after the installation of power plants are:

1) Widespread damage was occurring to pine and spruce species being grown throughout the study area as well as far beyond study area boundaries (25 x 40 miles),

2) Only once in over 7,000 hours of one-hour readings (monitoring) did the SO_2 ambient air levels exceed the national three-hour standard; the average one-hour readings for the 7,000 hours were at or less than 0.01 ppm, and

3) The pH value of rain water averaged 4.78 with a low of 3.50 during the spring of 1972 at 11 sampling sites.

Federal ambient air standards which have been set for SO_2, NO_x, and O_3 were rarely or never exceeded, and thus one would have to conclude that in the Mt. Storm area the current standards do not protect many species of plants.

4. Cumulative Effects

The majority of investigators have rarely utilized the concept of a yearly load of waste products on an ecosystem in air pollution studies, and, where it has been used, only small portions of the needed information have been acquired. However, the information which has been thus far obtained points out many of the "invisible" aspects of ecosystem disruptions caused by the impact of airborne pollutants.

In Anaconda, Munshower (1972) studied the presence and movement of heavy metals through the soils and plants of that ecosystem. Laird Hartman, a graduate student at the University of Montana Botany Department, is just finalizing three years of study on the presence and absence of microflora in the soils of the Anaconda area.

Munshower's and Hartman's studies demonstrate vividly that, in order to understand the impact of air pollutants on soil ecosystems in seriously polluted areas, one must consider the yearly load of airborne waste products upon that soil and not how much SO_2, SO_4, fluoride, arsenic, etc., was in a cubic meter of air for any given hour of any given day. If waste products of airborne emissions are not present in the ambient air at a given time, but rather are present in or on the soil or on the surface of vegetation, many if not most of these waste products become entangled in those ecosystems and continue to cycle in and react with the physical and biological components.

The total annual airborne emissions released from a stationary source should be considered if one is to predict the long term environmental impacts of those emissions. The introduction of excessive amounts of potentially toxic substances into an ecosystem over long periods of time has far greater, longer lasting effects than would concentrations of SO_2, O_3, NO_2 and HF in the ambient air which exceeded the state or federal standards five or ten times a year.

5. Secondary Agents

In some air pollution studies it has been suggested that portions of the major damage to or loss of susceptible plant species in air polluted areas is not entirely caused by either chronic or acute air pollution damage. Rather, it is due to secondary causal agents which can be either abiotic or biotic in nature.

For instance, a major causal agent of damage to coniferous species in The Dalles, Oregon, area is black pine scale which, under normal circumstances (in unpolluted areas), is a weak saprophyte insect that rarely causes severe plant damage (Compton et al. 1967). Studies by Carlson et al. (1974), involving damaged conifers in the Flathead National Forest, also demonstrated a massive insect infestation which occurred on weakened trees.

While most of the scientific literature which covers secondary causal agents in air polluted areas concerns conifer species, there is reason to assume that other plants are weakened by air pollution damage and will consequently be affected by secondary agents.

C. Emissions (Colstrip 3 and 4)

1. Pristine Areas

Numerous coal-fired power plants are either being proposed, designed, built, or going on-line in various areas of the United States. The majority of these plants are being planned for agricultural areas.

Excess killing occurs with the initial shock damage to the vegetation when a large stationary source of phytotoxic gases first goes on-line in a pristine area or an area where no detectable or only low amounts of pollutants were previously present (Hamburg and Stade, West Germany; Mt. Storm, West Virginia; and Garrison, Montana) (Gordon 1967-1972).

According to all data thus far gathered and reported, both indigenous and domestic species of flora and fauna in the Colstrip area have seldom or never been subjected to elevated concentrations of phytotoxic and zootoxic air emissions emanating from coal-fired power plants or any other large stationary source.

2. Air Pollutants

Even if all air pollution abatement equipment of Colstrip Units 1 through 4 perform at the designers' and manufacturers' predictions, there will be substantial tonnages of phytotoxic and zootoxic air pollutants emitted, which will impact the ecosystems of the Colstrip area. While there is a dearth of available scientific literature on the biological effects of plant emissions, there is some evidence that these emissions have caused economic loss of agricultural and non-agricultural species of plants in various areas of the world.

a. Sulfur Dioxide

The major phytotoxic pollutant emitted from coal-fired power plants is SO_2, and low concentrations of this gas in the ambient air cause visible and measurable damage to susceptible species of plants.

i. Acid Rain

Anthropogenic SO_2 emissions have been considered by both European and United States scientists to be the main cause of the increased acidic precipitation currently falling on large areas of Europe and the northeastern United States.

Colstrip Units 3 and 4 will have emissions more than twice those of Units 1 and 2. These added emissions will increase the area of acidic precipitation and the resultant damage. An ever increasing acidity of precipitation will occur throughout this area, and the major increase will occur in a 40 to 60 mile radius from the generating plants.

Because of its known sensitivity to acidic rains over that of other plant species growing in the Colstrip area, ponderosa pine will be the indicator to watch for the impact of this increasing acidic rainfall. There is a strong possibility that these acidic rains will cause measurable damage to other species of flora in the area, as well as some leaching of nutrients from the soils.

b. Other Pollutants

Several other air pollutants are emitted into the atmosphere from coal-fired power plants.

The total SO_2, NO_x, and HF emissions from all four generating plants would be greater than from all other sources within a 200-mile area of Colstrip. If one considers the fluoride emissions, even assuming 95% collection efficiency, there will be 17.9 tons of fluoride released per year, or 98.2 pounds per day, which will impact the ecosystems of the Colstrip area.

These pollutants, such as nitrogen oxides, fluorides, and heavy metals, have the ability singly and/or in combination (including SO_2 emissions) to cause visible and measurable adverse effects to the physical and biological portions of an ecosystem.

3. Cumulative Effects

In the Colstrip area the annual load of the emissions of all coal-fired generating units must be taken into consideration when predicting the environmental impact of those units being built and being proposed.

Several of the air pollutants emitted by coal-fired power plants are accumulated in tissues of flora and fauna species. The accumulation of these substances can occur over a period of several years in the long lived species and eventually cause a measurable change to the species diversity of an ecosystem.

4. Consistent Characteristics

Some characteristics are fairly consistent regardless of the diversity between two or more physical and biological areas.

Coniferous species within a polluted area are almost invariably the first plants which visibly manifest symptoms or eventually die because of toxic gases, especially those growing along ridge tops or on even slightly elevated areas. The phytotoxic gases such as sulfur and fluorides will accumulate at higher levels in these plants than in the same or any other species of plant growing in the valleys, riparian areas, or depressions.

It should be noted that those species of plants which accumulate the highest concentrations of either sulfur or fluorides present in the ambient air in a given sampling plot are almost without exception the most resistant species to these phytotoxic gases.

Seed production of the ponderosa pine as well as other species of plants will probably increase due to the stress caused by phytotoxic gases, but little or no increase of reproduction will occur. In fact, there should be a dramatic decline in pine seedling production in the Colstrip area, as there is now around the Anaconda and East Helena smelters.

At given ambient air levels for sulfur and fluoride compounds, more visible damage occurs to the vegetation in a dry area than in a wet area. During unusually dry years in wet or dry areas (Bellingham, Washington, and Columbia Falls and Garrison, Montana), there is more killing of vegetation over that in seasons when normal rainfall occurs.

5. Comparison to Billings Area

Nowhere in the scientific literature can one find the type of data which is needed to answer the environmental questions posed by the siting of 2,100 megawatts of coal-fired steam electric power generation in the Colstrip area of Montana. However there is currently an air pollution problem in Billings, Montana, and the biological and physical environmental parameters of this area are similar to those of Colstrip. One can utilize the similarities in predicting the potential air pollution problem for Colstrip.

Chemical and histological studies disclosed that both sulfur and fluoride air pollution damage to coniferous trees was prevalent as far as six miles away from the Corette plant and oil refineries located in Billings.

1) One to six miles from the Corette plant, the 15- and 27-month-old ponderosa pine foliage (1969 and 1968 foliage, respectively) contained an average sulfur content which was 50% to 60% higher than found in the same-age foliage from the Colstrip study sites.

2) The 15- and 27-month-old ponderosa pine foliage within one mile of the Corette plant contained 18.3 and 22.3 times more fluoride, respectively, than similar-age foliage from the Colstrip area.

3) Average fluoride levels in grass forage within one mile of the Corette power plant were 11 times that found in grass forage from Colstrip collection sites.

The biological changes and damages which have occurred in these heavily impacted areas of Billings and Laurel have not been studied. Although ambient air levels for one-hour to 24-hour periods have been studied, these levels bear little relationship to and do not assess the waste product impact upon the thousands of organisms in the soil over one to many years of continuous impact.

Regardless of the efficiency of the first two Colstrip generating units in their emission abatement, if similar units are added to the complex, there will obviously be an increase in the annual waste product load in the atmosphere. Tables 8-6 and 8-7 demonstrate these increases. The data in Table 8-6 are calculations utilizing the data from the Westinghouse report (1973) and the Billings and Laurel emission inventory summary from the state implementation plan (HES 1971) with the exception of the fluoride data. As can be observed on line 1 of Table 8-7, and line 5 of Table 8-6, the annual SO_2 emission at Colstrip, when and if all four units are operating, would be 66,342 tons more than is currently impacting the ecosystems of Billings and Laurel.

8.1.6. Wildlife and Fisheries

8.1.6.1. Inventory

The Colstrip Units 3 and 4 study area, which includes virtually all habitat types common in the Northern Great Plains region, lies within one of the most important game producing areas in Montana. The Yellowstone River, which crosses the study area, supports a large variety and quantity of both warm water and cold water fish species and provides habitat for large numbers of waterfowl and other migratory birds.

Game mammals include mule deer, white-tailed deer, pronghorn antelope, and bighorn sheep. Healthy populations of mule deer, showing excellent density and productivity, are found throughout the area. These deer are generally nonmigratory but show a seasonal change in habitat types. Both mule deer harvest and the number of hunters have been increasing. Major populations of white-tailed deer are found in association with riparian vegetation along the Yellowstone, Tongue, and Bighorn Rivers. Productivity and hunter harvest have been increasing, but white-tailed deer account for only 20% of the total deer harvest. Pronghorn antelope density is limited by the distribution of sagebrush, which is the most important food source on this species' winter range. Hunter harvest of pronghorn antelope has generally been increasing. A small but huntable bighorn sheep population is found east of Miles City.

Non-game mammals have not been studied or managed as intensely as the game species; however, their role in the ecosystem is no less important. Furbearers are primarily found along waterways, while most predators are distributed throughout the study area. Small mammals, occurring in nearly all habitats, are an important source of food for carnivorous birds, mammals, and reptiles. Several prairie dog towns are located in the area.

Five species of upland game birds occur. The most abundant of these is the sharp-tailed grouse, which is found in prairie grasslands throughout the study area. Many breeding grounds have been located. Sage grouse are abundant only in the plains north of the Yellowstone River. These birds are highly dependent upon sagebrush, which constitutes 100% of their diet on their winter range and breeding grounds. Ring-necked pheasants are present along most of the drainage bottoms, and populations are slowly increasing. Gray partridge are found throughout the study area but are not abundant. Relatively small populations of wild turkeys are found in ponderosa pine forests throughout the year and also in brushy drainages in winter.

TABLE 8-6

COMPARISON BETWEEN ANNUAL ESTIMATED EMISSIONS OF COLSTRIP UNITS 1 and 2, AND BILLINGS

EMISSIONS IN TONS/YEAR FOR:	WATER VAPOR*	SO_2	NO_2*	PARTICULATE	TOTAL FLUORIDE**
Colstrip 1 and 2 only; 20% control	2,119,920	39,547	20,761	185,011	91.
Colstrip 1 and 2 only; 40% control	2,119,920	29,661	20,761	138,758	68.3
Colstrip 1 and 2 only; 95% control	2,119,920	2,471	20,761	11,563	5.7
Colstrip 1 and 2 only; Control per Westinghouse EIS	2,119,920 2,119,920	29,661	20,761	1,156	3.72
Billings & Laurel Area	Unknown	25,638	16,699	3,735	20.0

* No controls
** Assume 33 ppm F^-

TABLE 8-7

COMPARISON OF ESTIMATED EMISSIONS FROM COLSTRIP UNITS 1-4 WITH BILLINGS AREA EMISSIONS

Assuming Equal Distribution On a Given Land Surface	Location	Water Vapor	SO_2	NO_2	Particulate	Total Fluoride Gas & Particulate
Stack Emissions Running at Full Capacity	Colstrip	6,570,000 -	91,980	64,824	3,609	17.9 tons/yr. or 35,846 lbs/yr.
	Billings		25,638	16,699	3,735	40,000 lbs.
Emission Load Impact on 1 Sp. Mile in a 25 Sq. Mile Area Each Year	Colstrip	262,800	3,679	2,592	144	1,433 lbs/yr.
	Billings	-	1,025.5	667.9	149.4	1,600 lbs
Emission Load Impact on 1 Sq. Mile in a 100 Sq. Mile Area Each Year	Colstrip	65,700	919	648.2	36	358 lbs/yr.
	Billings	-	256.4	166.9	37.4	400 lbs.
Emission Load Impact on 1 Sq. Mile in a 500 Sq. Mile Area Each Year	Colstrip	13,140	184	109.6	7.2	71 lbs/yr.
	Billings	-	51.3	33.4	7.5	80 lbs.

The Yellowstone River and its tributaries are used by large numbers of waterfowl as breeding areas, wintering areas, and loafing areas during migration. Canada geese breed along the Yellowstone River and its tributaries, especially on islands, and there is some indication of a recent buildup of breeding populations. Many species of ducks are observed along the Yellowstone during spring migration, although information is limited as to which species nest there.

Several species of raptors and large water birds are also known to breed in the study area. A number of heron rookeries are found along the Yellowstone, and large numbers of bald eagles concentrate along the Yellowstone during spring migration.

The Yellowstone River, which is the largest free-flowing river in the continental United States, is of tremendous importance as a fishery, from the excellent cold water fishery of the upper and middle river to the diverse warm water fishery of the lower river. Within the study area, the Yellowstone supports a warm-water fishery, including paddlefish, sauger, walleye, northern pike, channel catfish, and shovelnose sturgeon. Large numbers of non-sport fish also inhabit the river and represent a lightly utilized but potentially valuable resource. Thirty-nine fish species have been recorded in the Yellowstone between Hysham and Miles City. The three major tributaries of the Yellowstone, the Bighorn, Tongue, and Powder Rivers, are important spawning and rearing areas for certain fish species migrating from the Yellowstone.

The physical and chemical features of the Yellowstone River are the basis for its biological diversity and productivity; the present array of organisms which inhabit the river are adapted to exist within the extremes of natural variation of these parameters. Flow regimes in the Yellowstone are characterized by an annual cycle of flood and drought, with a ratio of maximum to minimum flow as high as 100 to 1 at Billings. The spring runoff pattern flushes away silt deposits, which would eliminate potential spawning areas and reduce the available food producing areas. The annual range of temperature in the Yellowstone in the study area is from 32°F to over 84°F. The degree of sinuosity of the Yellowstone, with its side channels, backwaters, islands, and shoreline areas, provides for a diversity of habitat types.

Aquatic invertebrates, which are most abundant in riffle areas, are of extreme importance to the fish fauna of the Yellowstone River. Many fish species feed on them exclusively, while the young of other species are dependent upon them to varying degrees. In addition, aquatic invertebrates are particularly sensitive to changes in the aquatic environment, and slight changes in water chemistry or flow will be reflected by large changes in the invertebrate fauna.

8.1.6.2. Impacts

The construction and operation of Colstrip Units 3 and 4 would produce four types of negative impacts upon wildlife: (1) destruction of terrestrial habitat through strip mining and plant construction, (2) pressures resulting from population increases, (3) air and water pollution as a result of emissions from the plants, and (4) disruption of the normal flow regimes of the Yellowstone River due to water withdrawals.

More than 12,000 acres of wildlife habitat in the study area will be destroyed over the projected 37-year life span of plant operations. Most of this habitat destruction will result from the strip mining of coal to fire the generation plants. The proposed mining areas contain fair to excellent densities of mule deer, several known sharptail grouse breeding grounds, and habitat for all other classes of wildlife. The re-establishment of most wildlife species on strip-mined land will be attained only after the long, slow process of natural succession returns suitable habitat.

Additional habitat loss is expected as a result of an estimated population increase of over 4,000 people; this habitat loss as well as that resulting from the construction of the plant itself is permanent. The projected population increase will undoubtedly result in substantially more legal and illegal hunting pressure upon wildlife, as well as harassment of wildlife from recreational pursuits such as motorcycling and snowmobiling. The amount of sewage and other organic wastes entering the Yellowstone and its tributaries could also increase.

Emissions from the proposed coal burning generation plants, including sulfur dioxide and particulate matter containing a variety of trace elements, will have an impact upon vegetation and upon terrestrial and aquatic animals. Sulfur dioxide, when released into the atmosphere, is slowly converted to sulfuric acid and is returned to the ground as acid rain. This acid is carried by runoff into streams and lakes, where it accumulates and can significantly lower pH values and reach concentrations toxic to living organisms. Coal-burning power plants are also a source of mercury contamination. Mercury and its compounds are highly poisonous to aquatic organisms, which are known to concentrate mercury in their bodies until it reaches lethal levels. Mercury also accumulates in the food chain and is most likely to reach toxic concentrations in predatory fish, birds and mammals.

A large, continuous flow of water is required by the cooling towers of coal-burning power plants; this water would be taken from the Yellowstone River, altering its natural flow regime. The water withdrawals of Colstrip Units 3 and 4 may be only the beginning of a number of water-consuming energy conversion complexes (which would use up to 3.36 million acre-feet of Yellowstone Basin water). Whether withdrawals occur in a few large depletions or in numerous small withdrawals is irrelevant; what is important is the probable cumulative impact.

Alterations of the natural flow pattern of the Yellowstone River by water withdrawals would change the natural physical and chemical features of the river, which in turn directly affect the biota. Reduced river flows would have a detrimental effect on nesting geese, causing islands to become continuous with the river banks and increasing the vulnerability of nests and adults to hunting and predation. Reduced flows would cause the river to freeze over earlier than under present conditions, causing waterfowl and eagles using these areas to migrate south earlier. Also, reduced flows would prolong ice cover in spring and reduce ice-gouging of shore vegetation. Several species of fish found in the Yellowstone may require peak flows for migration and spawning.

Lower flows may also result in increased water temperatures, lowered water velocities, and a reduction in the extent of riffle areas. Any increase in water temperature decreases the solubility of dissolved oxygen while at the same time increasing the oxygen demand of organisms; extreme temperatures may reach the lethal limit of certain fishes. Lowered water velocities would cause increased sedimentation of the river bed, eliminating potential spawning areas and reducing the available food producing areas. Riffle areas, which provide the primary food production for fish, could be lost due to sediment buildup.

8.1.7. Radiation

Radiation studies were conducted by the Montana Department of Health and Environmental Sciences for the purpose of identifying baseline radioactivity levels and evaluating radiation impact in the Colstrip area. The studies included analyses of ground and surface water, air, soil, and vegetation. No unusual levels of radioactivity were detected for any of the parameters measured.

Because of the presence of small amounts of naturally occurring radioactive elements in coal, some radioactive material would be contained in the coal combustion by-products of the power plants.

Radioactivity contained in stack effluents would be transported by the atmosphere from the generating plants to animals and humans, water, soil, and vegetation. Preliminary calculations of ground level concentrations of radioactivity resulting from the proposed Colstrip Units 1 through 4 emissions, using the long and short term Gaussian models described in Section 8.1.1.2., have not indicated that the maximum permissible concentrations of radioactivity established by the Atomic Energy Commission, would be exceeded for twenty-four hour or annual periods. Based on these preliminary indications, significant impacts on human or animal health, soils, water, or vegetation due to radiation emitted with stack effluents are not anticipated. However, as noted in Section 8.1.1.2., sufficient data was not available to complete the short term modeling analysis prior to the completion of the draft impact statement. The preceding conclusion must therefore be considered preliminary.

The greatest potential for Colstrip generating plant operations to cause a significant increase in the concentration of radionuclides in the surface and ground water is possible contamination from the ash storage pond. Assuming all the ash not emitted from the stack reaches the ash pond, the concentrations in the pond of uranium and thorium would be 7.3 $\mu g/g$ and 18.2 $\mu g/g$, respectively. These concentrations are typical of those found in many sedimentary rocks such as black shale and the more quartz-rich igneous rocks such as granite. As with other contaminants, the radioactive materials cannot reach the ground water if the ash pond is properly sealed and not allowed to overflow.

8.2. Cultural Environment

8.2.1. Land Use

8.2.1.1. Inventory

Land uses in the study area can be categorized into linear patterns, including transportation and utilities, and site patterns, including agricultural land uses, urban and residential land uses, industrial areas, water areas, recreational land use, and woodlands. In addition to these existing land-use patterns, future land-use changes may make use of land use potentials and/or proposals.

A. Linear Patterns

The study area is traversed by roads ranging from major freeways (I-90 and I-94) to gravel and primitive roads. Burlington Northern and Chicago, Milwaukee, St. Paul and Pacific freight railways serve the study area, and Amtrak offers east-west passenger service along the Yellowstone River. The only major public carrier airline in the study area is the Frontier line. Airports and landing strips are scattered throughout the study area; the largest of these is located at Miles City. No new major transportation facilities are planned.

Several high-voltage transmission lines, as high as 230 KV in capacity, cross the study area. These include lines from the Yellowtail Dam power plant and Colstrip Units 1 and 2. The Montana Power Company plans to construct two 500 KV transmission lines leading westward from the proposed Colstrip Units 3 and 4; future coal development would necessitate additional lines. Gas and oil pipelines transport natural gas and oil from major fields in the study area.

B. Site Patterns

Farming and ranching is the major source of income for residents of the study area. Irrigated land, dependent upon an adequate water supply, is limited to river valleys and floodplains along major rivers and streams. The amount of irrigated land in the study area is increasing, but much land classed as "potentially irrigable" may never actually be irrigated due to the lack of available water. A relatively small amount of dry cropland is scattered throughout flat upland benches. Most of the remainder of the study area is rangeland, which supports an important livestock industry and habitat for many species of wildlife (see Land Use - Site Patterns Map).

The major communities are Miles City, Hardin, Broadus, Forsyth, and Terry. Scattered built-up areas, including subdivisions and trailer parks, surround these urban centers and are dispersed throughout the study area, primarily along drainages. The major heavy industry is the strip mining of Fort Union coal. Urban areas, scattered built-up areas, and industrial areas are expected to increase in the near future if coal-related development proceeds.

The study area also encompasses many small water areas, including lakes and reservoirs, and a relatively small amount of commercial and noncommercial woodland, mostly within the Custer National Forest.

C. Land Ownership

Land within the study area is owned or administered by the U.S. Forest Service, the Bureau of Land Management, the Bureau of Reclamation, the State of Montana, and private individuals and corporations. The Northern Cheyenne and parts of the Crow Indian Reservations are included.

8.2.1.2. Impacts

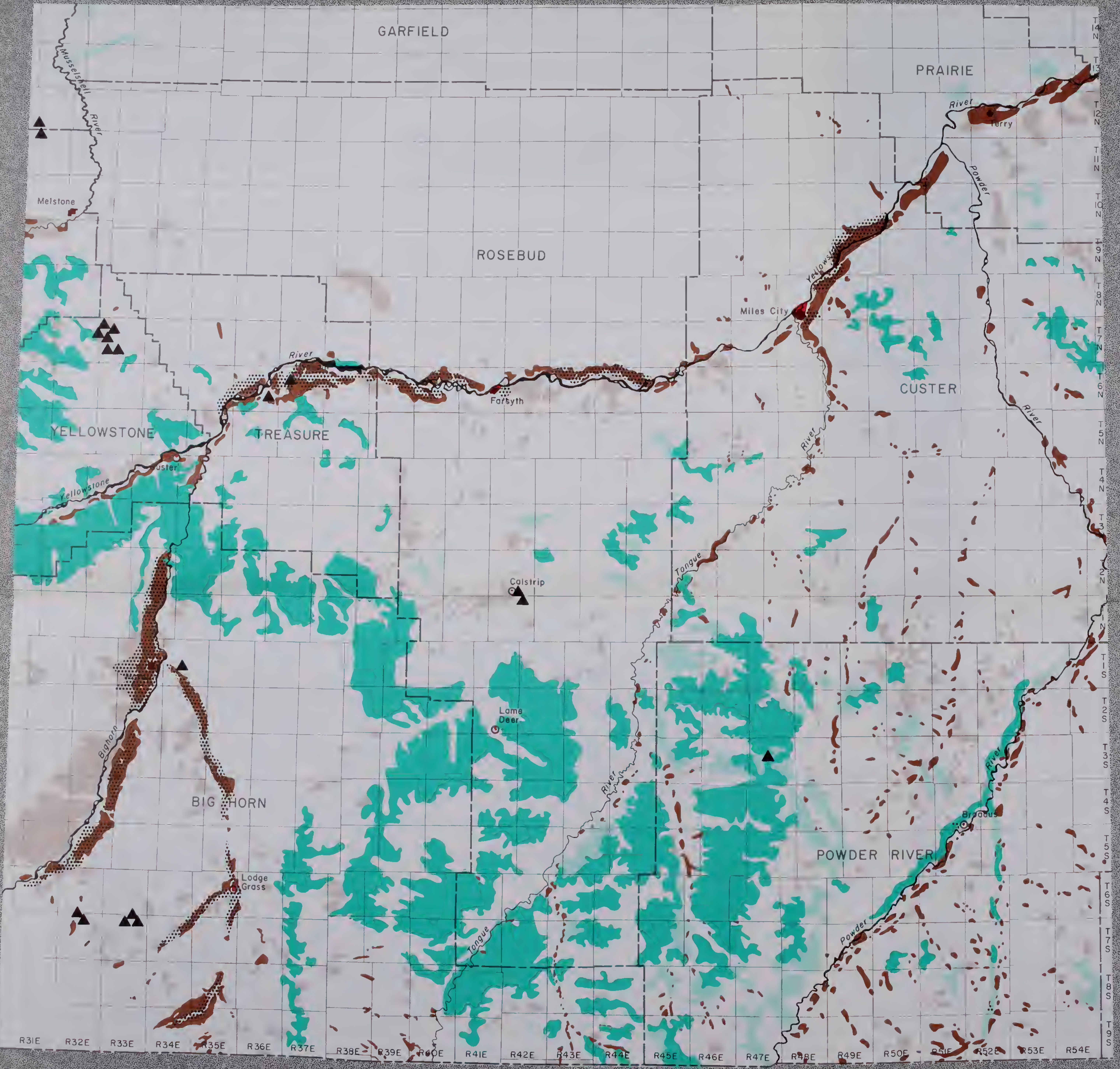
The land use impacts initiated by the construction and operation of Colstrip Units 3 and 4 represent changes from existing land use and the introduction of new determinants for future land use changes. It should be noted that land use is not a static, isolated process, but is constantly responding to climatic, environmental, economic, and social fluctuations. This indicates that the construction and operation of Units 3 and 4 would initiate a series of land use changes directly in response to the plants as a land use.

The land uses that have been inventoried are agricultural, recreational, urban, and historical. The construction of Units 1 and 2 is changing the area's image from agricultural to industrial, and Units 3 and 4 would reinforce that image.

Plants 3 and 4 would occupy only about four acres and, with the addition of switchyards, coal storage areas, parking and other necessary facilities adjacent to the plant, would total approximately 200 acres.

Northwest of Colstrip and Units 3 and 4, 150 acres of bottom lands would be used for a surge pond to store water for emergency situations (Westinghouse 1973). A dam will flood the lower lands and create a water body that will have potential for recreation, as will adjacent lands.

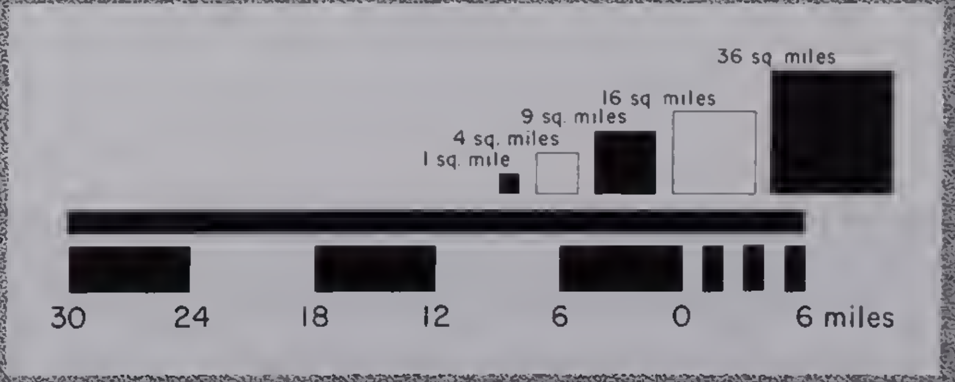
Southeast of Units 3 and 4, a 350-acre ash pond (Westinghouse 1973) will displace more rough land and dry cropland. Because the normal plant life span is about 37 years and this pond has a projected use span of 20 years, more land may eventually be needed for ash disposal. The lands around the pond, notably downwind, will be affected by the odors associated with ash pond functions, thereby limiting the types of land-use suitable for those lands, especially for human habitation.



EXISTING LAND USE
SITE PATTERNS

🟥	Urban Areas & Small Communities
▨	Scattered Built-up Areas
▲	Industrial Sites
🟫	Irrigated Land
☐	Dry Cropland
☐	Rangeland and Barren Areas
🟩	Commercial Woodland
☐	Non-commercial Woodland

SOURCE: BLM, SCS, DNRC, ASCS



The land uses mentioned would directly utilize about 700 acres and indirectly affect adjoining land use by such factors as emitting odors or attracting recreationists. Another additional secondary impact would result from the generation of roads and utility corridors between the plants, ash pond, and surge pond. These linear elements would entail construction and operating nuisances, such as dust and noise, and possible obstruction of surface drainage. Automobile access would be provided to lands not now accessible, but only within a four-mile radius of the plants.

A greater impact that would affect and potentially change land use in the Colstrip area would be caused by strip mining. Approximately 5,500 acres of surface land would be mined over a 37 year period to provide the 6,500,000 tons of coal annually needed by Units 3 and 4. If the reclamation process is successful, this would be a short term disruption of land use and there would be the potential of returning land to agriculture and wildlife habitat; if the process is not successful, these lands could indefinitely be rendered useless.

Sixty-three archaeologic sites could also be destroyed depending on the application of state strip mine laws, and the artifacts, lithographs, and other associated remnants of aboriginal American habitations and land use would be lost.

If the groundwater aquifers are disrupted, water supply and quality could be affected over an area much larger than the 5,500 acres mined. This could initiate land use changes due to a lack of water for livestock, humans, or crops. (The aquifer affected by the first phase of mining, for example, supports nineteen wells and three springs.)

Other secondary impacts could result from stack emissions. Those lands downwind which could undergo a change in soil chemicals or vegetation communities could also be expected to have land use changes, determined by the specific effects of the soil additives or the nature of vegetation changes.

Another series of impacts would be attributable to the population increase. The projected population (high estimate) in Rosebud County for 1977 is about 16,000, an increase of approximately 10,000 people from 1972, but this population is expected to decrease during the operational phase of power generation.

Housing needs increase with population growth. According to the first phase of Colstrip's development plan, 1,780 additional persons would live on 243 acres of land northwest of the plants (Ken R. White Company 1972); additional phases of planned development are also located to the northwest. Once again dry cropland, rangeland, and barren land will be eradicated as the existing town expands its grid pattern of streets. This plan also includes additional acreage for a golf course, bicycle paths, and open space.

Some employees will be drawn to larger nearby towns, such as Forsyth, Miles City, and Billings or to the rural landscape. Development pressure can be expected on Montana Route 315 between Interstate 94 and Colstrip, and some of the agricultural lands adjacent to that road will be considered for either housing or commercial development.

The population increase will demand and use recreational facilities. The golf course, bicycle paths, and town open space will satisfy some of these demands, but recreational pressure for activities such as hunting, snowmobiling, or off-road touring will be transferred to public and private lands in the area. This pressure can disrupt agriculture such as when gates are left open or cropland is abused, and land use changes may eventually be initiated to avoid these conflicts.

8.2.2. Social and Economic Factors

8.2.2.1. Population Characteristics

The center of potential population impact resultant from the construction of Units 3 and 4 would be Rosebud County, with a population density of 1.2 persons per square mile. The population of Rosebud County, 6,023 in 1970, declined by 2.5% since 1960, but already this downward trend has been reversed with the development of coal reserves. Units 1 and 2 may well have brought an increase in the population of the county of over 30% between April 1, 1970, and August 1, 1974.

The primary location of growth during this period has been the town of Colstrip, although the county seat, Forsyth, and smaller towns in the area have also experienced considerable population growth. The growth has been so rapid, in fact, that no current record of population has been able to keep up with the actual population growth at either the county or municipality levels.

Growth has largely taken place due to the influx of temporary skilled and semi-skilled construction workers and their families. Accompanying this majority have been supervisory, management and service personnel associated with the Colstrip development. Somewhat independent of this growth has been additional growth associated with coal extraction elsewhere in the county. Traditionally a rural farm and rural non-farm population, the residents of Rosebud County are rapidly experiencing proportionate increases in non-agricultural workers.

Rosebud County has a large, indigenous minority population. The Northern Cheyenne Indian Reservation, headquartered at Lame Deer, is among the largest reservations in the state, contributing 30% of the total county population in 1970. This percentage is the fourth highest in Montana. Also associated with this particular non-white population are the second highest fertility ratio in the state (473 in 1970), the highest crude birth rate in the state (27.5% in 1970), and the second highest percentage of children under five years in the state.

Optimal economic characteristics have historically been lacking in Rosebud County. 10.3% of the families fell below the poverty level in 1970, the fifth highest such percentage in the state. The mean family income was the fourth lowest in the state in 1970, while per capita income was only one position higher. Consequently, Rosebud County had the second highest percentage of persons on welfare in the state in 1970. Rates of unemployment have been high, and the values of housing have been low. In general, the economic position of Rosebud County has not been an advantaged one.

Educationally, too, Rosebud County has occupied a rather unenviable position. In 1970, Rosebud County fell among the lowest ten counties in Montana for percentage of 14 to 17 year olds in school (14.7% were not in school), average educational achievement by adults (11.5 years), the percentage of elementary school children in public school, and the percentages of male and female high school graduates.

A. Impacts on Population Growth

The population projections used in this report focus on Rosebud County alone. While coal development has stimulated some population growth in neighboring counties, over 80% of the current population growth has been located in Rosebud County. Given the long distances between communities in eastern Montana and relatively underdeveloped systems of transportation, it is anticipated that future population growth will continue to mirror that which has already taken place and will remain largely within Rosebud County. Thus, the projections contained within this report are for Rosebud County.

The projections should be interpreted according to the following assumptions.

1) Net migration will equal zero. This implies an equal number of in-migrants and out-migrants and that both categories share similar characteristics.

2) Population categories will continue to maintain their current natality and mortality characteristics.

Volume 3b, Section 11.2.2.1. of this report contains an extended discussion of Rosebud County population totals and a description of the characteristics of sub-populations (i.e. county population by educational level, race, occupational category, etc.).

Three projections are computed for each population and sub-population indicating differing rates of population increase. Projection I reflects the lowest rate of increase, and is an expression of what the population would be if the age-sex structure and natality and mortality of the 1970 population remained unchanged. Projection II (labeled Assumption #1 on Figure 8-7) assumes a slightly younger, hence more rapidly growing, age-sex structure. Projection III (labeled assumption #2 on Figure 8-7) reflects a still younger, and slightly longer living age-sex structure, hence the most rapid population growth of the three projections.

Associated with, and in addition to these sets of projections, are three growth curves computed for especially high population increase categories affected by the possible construction of Colstrip Units 3 and 4. These estimates of population growth appear on the bottom of the graphs. In order to obtain the highest probable growth for a time period, take the highest of the population estimates and add them to the highest population projection. Add the lowest population estimate to the lowest population projection in order to obtain the lowest probable population, given that Units 3 and 4 are constructed. Intermediate populations may be obtained by combining other combinations of estimates and projections. For example, in 1975 the high population estimate associated with mine and construction jobs will total approximately 2,800 persons. The base population is projected at 6,500. Added together, the county population total is projected to be near 9,300 persons. The Rosebud County overall population projection is shown in Figure 8-7.

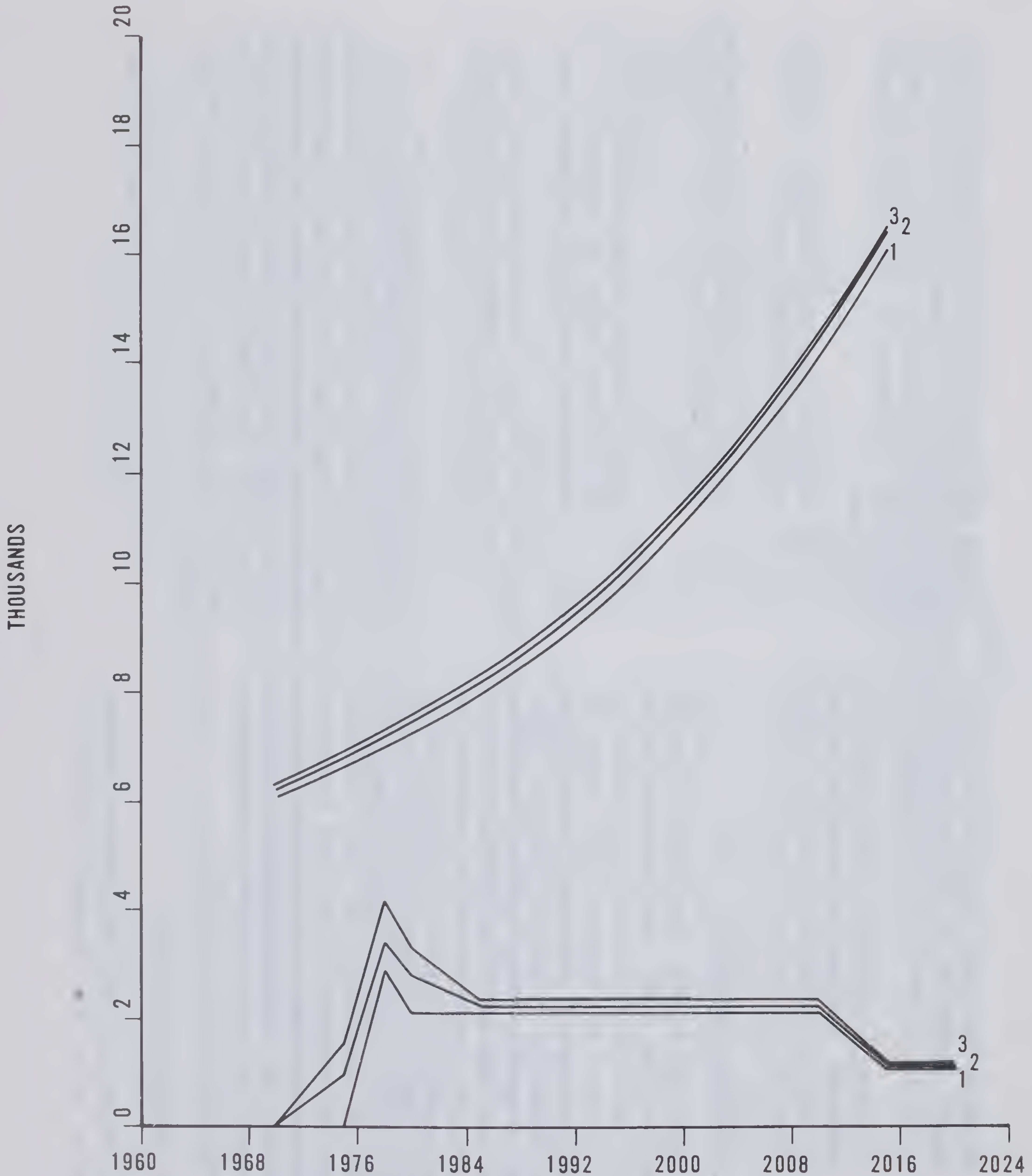
A. The Future

Current indications are that Rosebud County is being and will continue to be affected more by coal development than are the adjoining counties for some time to come. Extensive development already is underway and promises to increase if coal becomes an increasingly important source of fuel for the region and nation. The demographic impact of this development will be extensive. The percentage increase of the population was around 30% between 1970 and 1974. Although this rate of increase will be reduced as the population base increases, a high rate of growth will continue through 1978 or 1980, especially if Units 3 and 4 are constructed.

In making these projections, three separate population categories were used.

1) Base population, which refers to the indigineous population of Rosebud County as of 1970 with additions for natural increase because of natality, mortality, and changing occupational, age, and sex structure.

2) Direct employed permanent population (hereafter referred to as direct population) which refers to workers and their



ROSEBUD COUNTY POPULATION PROJECTION

1970–2020 1–NO EXTRA GROWTH 2–ASM#1 3–ASM#2

ASM = ASSUMPTION

FIGURE 8-7

families who will hold jobs as operational personnel at the mines and in generating plants in Rosebud County.

3) Construction population, which refers to personnel employed in the construction of the generating units and their families.

1. Base Population Forecasts

The base population forecasts (shown in Tables 8-8, 8-9, and 8-10) were developed on the assumption that other major coal development in addition to that at Colstrip will occur in Rosebud and surrounding counties. By creating new basic employment for residents of Rosebud County who might otherwise move, and by causing an influx of new residents, these additional development activities would offset the out-migration that has previously occurred in Rosebud County. The forecast, then, is a direct projection of the 1970 population, assuming both no out-migration and continued reproduction at the 1970 rate. Short-range fluctuations in the base population due to construction activity at Colstrip are not reflected in the base population forecasts because these fluctuations would be very temporary and extremely difficult to predict.

2. Direct Population Forecast

Full mining and plant operation at Colstrip will result in a new permanent population of workers and their families. The permanent employment at Colstrip is predicted to be 693 by 1980./1 The following assumptions were made to derive the estimates of the direct permanent population.

1) None of the new permanent employees would be over the age of 64.

2) Eighty-five percent of these workers and their families would reside in Rosebud County.

3) Eighty percent of the workers would be married and have an average of 2.5 dependents each (1.5 children and 1 spouse).

4) School-age children would constitute 30% of the new permanent population./2

3. Construction Population Forecasts

Construction activity on Units 3 and 4 would create a temporary population influx. The peak construction employment at Colstrip is predicted to be 1,750 and would occur between 1977 and 1979./3 The following assumptions were made to derive the estimates of the construction population:

1) None of the construction employees would be over the age of 64.

TABLE 8-8

ROSEBUD COUNTY POPULATION PROJECTIONS WITH THE CONSTRUCTION OF UNITS 1 AND 2 AND ASSOCIATED MINE EXPANSION*

	1970	1975	1978	1980	1985	1990	1995	2000
Total[1]	6,032	9,357	8,137	7,862	8,563	9,337	10,253	11,367
Base[2]	6,032	6,501	6,818	7,117	7,818	8,592	9,508	10,632
Direct[3]		745	745	745	745	745	745	745
Construction[4]		2,111	574					

[1] See proceeding discussion for a description of the assumptions on which these forecasts were based.

[2] Base population forecasts include the 1970 Rosebud County population projected to the year 2000. Included as base population are the families of the approximately 33 WECO personnel working at Colstrip in 1970.

[3] This forecase assumes 250 mine personnel and 60 personnel operating Units 1 and 2 (Westinghouse, 1973). Correction has been made for the 33 WECO personnel counted in the Base population category. The projections also incorporates a 5% expansion figure (i.e. the 1975 WECO Work force will total 325 men).

[4] This forecast assumes 1103 construction personnel on the job in 1975. This figure is 5% addition to the figure of 1,050 men reportedly working on construction at Colstrip as of September 13, 1974. Manpower estimates supplied by the Billings Office of the Montana Employment Service. The construction related forecast for 1978 assumes 300 men on the job completing the final details of construction.

*To see the population effect of Units 3 and 4, subtract the projected total county population of Table 8-8 from that of Table 8-9.

TABLE 8-9

POPULATION PROJECTIONS FOR ROSEBUD COUNTY WITH THE CONSTRUCTION OF UNITS 1-4 AND ASSOCIATED MINE EXPANSION*

	1970	1975	1978	1980	1985	1990	1995	2000
Total	6,032	9,357	11,849	9,374	9,501	10,245	11,191	12,305
Base	6,032	6,501	6,818	7,117	7,818	8,562	9,508	10,622
Direct[1]		745	1,683	1,683	1,683	1,683	1,683	1,683
Construction[2]		2,111	3,348	574				

[1] This forecast assumes 325 permanent workers in 1975 and 693 permanent workers in 1978. The latter figure is then stabilized to reflect full production at Colstrip.

[2] This forecast assumes 1103 construction workers in 1975, an employment peak of 1750 construction personnel in 1978. Tapering to 300 in 1980, and dropping to zero thereafter.

*To see the population effect of Units 3 and 4 subtract the projected total county population of Table 8-8 from that of Table 8-9.

TABLE 8-10

ILLUSTRATIVE DISTRIBUTION OF PERMANENT ROSEBUD COUNTY POPULATION[1]

	Alternatives			
	Low Impact on Colstrip[2]		High Impact on Colstrip[3]	
Area	1980	1985	1980	1985
Rosebud County	8800	9501	8800	9501
Colstrip	2500	2500	3500	4000
Forsyth	2800	3500	2300	2500
Lame Deer	1200	1500	1200	1300
Rural	2300	2001	1800	1701

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[1] These alternatives are merely illustrations of the potential effect Western Energy decisions might have on the population distribution of Rosebud county.

[2] This alternative assumes: 1) that WECO will limit the population of Colstrip to 2,500, resulting in a high population increase at Forsyth, and a moderate increase at Lame Deer; and 2) our migration from rural areas of the county will occur.

[3] This alternative assumes: 1) that major coal related population increases will be concentrated at Colstrip; 2) that moderate population increases will occur in Forsyth and Lame Deer; and that our migration from rural areas of the county will occur.

2) Eighty-five percent of the new construction workers and their families would reside in Rosebud County.

3) Fifty percent of these workers would be married and have an average of 2.5 dependents (1.5 children and 1 spouse).

4) Each married worker would have an average of 1.1 school age children./4

Three qualifications with regard to the population projections must be indicated. First, for the years 1975 and 1978, the "direct" population forecast assumes that the operating mine and power plant personnel will be on the job or located in Rosebud County in training for their future employment. As such, the population projections for this category of workers may be slightly inflated since the requisite construction will not be completed, and the operating work crews may not have reached the full employment peak.

Second, the population projections derived for the construction personnel are tenuous, at best. Labor disputes, difficulty in receiving necessary construction materials, changing conditions in the labor market, and a host of other factors subject construction projects to radical changes in the size of their labor forces. The projection of 1,750 construction personnel in 1978 is approximately 100 men higher than the maximum projected by the Westinghouse Report (1973). However, if the project experiences a growth in its construction labor force similar to that at the Bridger Power Plant in Rock Springs, Wyoming, then even 1,750 construction personnel will be extremely low. The Bridger project predicted a maximum of 1,200 workmen, but 3,000 men were required ("Rock Springs, Wyoming" 1974, p.5). A similar phenomenon in Colstrip using the Westinghouse (1973) figure, of an employment maximum of 1,658 construction personnel would indicate a 1978 peak of 4,145 men and a total construction population of 7,927. If the base and direct population of Rosebud County are added to this figure the total 1978 peak population would be 16,428.

Finally, the population projections of this section do not contain an employment multiplier. As such, the projected populations are based on rates of natural increase and in-migration to construction, mine, and power plant jobs. The population effects of secondary employment are neglected. It is implicit in these projections that a large portion of the secondary employment opportunities will be filled by residents of Rosebud County. For example, the wives of construction workers may work as waitresses, beauticians, and so forth. Also, given the small size of the communities in Rosebud County, a portion of the secondary jobs, especially those of a specialized nature, may be located in the urban areas of Miles City or Billings. Thus, while it is acknowledged that secondary employment may lead to additional in-migration and population increase, its total effect is yet unspecified.

Given the qualifications attached to the population projections of this section, it is suggested that the figures contained in Tables 8-8 and 8-9 be interpreted as a low population forecast. Changing demands for construction personnel may sharply increase and grossly inflate the county population./5 Furthermore, the effects of secondary employment are unspecified and may add to an increase in the population of Rosebud County.

The population projections contained in this section are at variance with those located in Section 8.2.2.4. The difference is explained by the different assumptions under which each set of projections was conceived. The projections of this section reflect a social perspective with population growth primarily a product of the mortality, natality, and migration. The projections of Section 8.2.2.4. reflect an economic perspective. That approach largely draws its conclusions about population growth by estimating employment opportunities and assuming in-migration to fill each available job opening. In examining each set of population projections it is important to keep these distinctions in mind. For example, if Units 3 and 4 are built and the mine is expanded to meet the needs of these facilities, the social perspective toward estimating population growth indicates a county population of 11,849 during 1978 when construction activities are at a peak. When construction activities taper off and the generating plants become operational, the 1980 population is estimated at 9,374. For the same years, the economic perspective generates considerably higher population estimates. In 1978 the population is estimated at 15,119, diminishing to 12,994 in 1980 when Units 3 and 4 would be operational.

A primary difference between the two sets of projections is that the social perspective does not contain a multiplier for population growth associated with secondary employment. With every increase in primary employment some secondary employment is also induced, and, in most cases, there is some in-migration to fill such jobs. Thus, by ignoring the effects of secondary employment, the population projections made from the social perspective should be considered a low estimate of population growth. On the other hand, the economic perspective with its implicit assumption of in-migration to fill all secondary employment opportunities, ignores the fact that many secondary jobs are filled by local residents. Thus, the population projections from the economic perspective (Section 8.2.2.4.) should be considered a high estimate of population growth.

8.2.2.2. Social Structure

A. Ethnographic Study

The purpose of this ethnographic report is to present the views, thoughts, feelings, and reactions of people living in and around Rosebud County regarding the impacts which Colstrip generating Units 3 and 4 are likely to have on the local social patterns and processes, that is, on the residents' way of live. Ethnographic research is concerned with coal industrialization as seen by representatives of all known points of view. The research method selected for this study does not seek to evaluate why these reported views are held nor to substantiate reported difficulties.

Findings have been based upon more than 200 interviews with carefully selected persons from Colstrip and Forsyth, Montana, including the Decker-Birney-Ashland area. Interviews were conducted from October 1973 through May 1974 using a sociological sampling approach, which enlists the help of interviewees in identifying and locating persons locally thought to be good representatives of various groups and points of view.

This report focuses upon the views and reactions of landowners, newcomers, and townspeople in the study communities and surrounding vicinities. The latter interviewees represent a variety of occupations and professions, including government officials, merchants, store employees, land brokers, financiers, health professionals, welfare workers, students, educators, laborers, engineers, housewives, clergymen, tribal representatives, law enforcement personnel, senior citizens, newsmen, and lawyers.

Changes in the way of life of local residents are already taking place. These changes include shifts in the selection of friends, strains in communicating with friends and neighbors of long standing, the making of social class alignments previously considered unimportant, a shift in the established power structure from the ranchers to the new mining industrialists, the need to live with constant and increased uncertainties for which planning is virtually impossible, a keen interest on the part of some merchants and businessmen in monetary gain, the need to accommodate the invasion and requirements of newcomers who subscribe to different lifestyles and value systems, and the loss of a sense of community.

Until recently, residents' sense of community had always been good in Colstrip and Forsyth. Now, however, this sense of community is definitely breaking down, especially in Colstrip where the proportion of newcomers to established residents is greatest. The sudden influx of newcomers throughout the area is affecting every aspect of established town life. Law enforcement, health care services, churches, and especially the schools are feeling the pressures of increased population. Local residents are fearful of rising taxes to pay for the expanding and immediate social needs created by development. /6 The arrival of various new goods and services is making people less dependent on their neighbors and on being neighborly.

1. Ranchers

It seems evident that coal development will severely threaten the viability of the ranching culture wherever mining (or related energy development activities) occurs. Coal and power companies have put landowners in the position of playing unfamiliar roles in an area where little or no industrialization has occurred. Ranchers are poorly prepared to bargain and use nonadversarial values in negotiating, whereas companies are playing adversarial roles with great facility. Ranchers, who for the most part view the corporations as amoral, cold-blooded, and motivated by profit, are at a great disadvantage in dealing with the companies, which have better information, trained and experienced staffs, and an operational ethic suited to treating landowners as exploitable natives. Ranchers have few established information channels in which they can fully trust and believe. Also, ranchers persist in evaluating land propositions mainly or entirely in an agricultural rather than industrial frame of reference, putting themselves in a very vulnerable position in negotiations. Companies take advantage of their knowledge that ranchers tend not to discuss land negotiations with each other, reflecting the Western traditions of not openly passing judgment on how neighbors manage their land and cattle, of not discussing details of personal business matters, and of not imposing one's views on others.

Ranchers' highly successful adaptation to the special demands of raising cattle in the West has left them very vulnerable to industrial or comparable socioeconomic interventions.

Love of the land is still widespread and evident, and people want to retain these ties. Handling leasing or the sale of one's property is often threatening or discouraging for ranchers in southeastern Montana. As a group, they are not favorably inclined toward development nor desirous of economic benefits given expected "people pollution" and changes in life-style which would accompany projected, large-scale industrialization. /7.

2. Townspeople

Coal development does not constitute a major issue for most old-time townspeople interviewed in Forsyth. Either their lives have not been directly affected by it or the ill effects they do anticipate, such as air pollution, are not feared to grow to an intolerable magnitude. For the most part local residents are happy with the economic benefits which have accompanied development and do not feel that their way of life has changed much--nor is it expected to unless the population influx becomes enormous. They are concerned about obtaining an adequate number of professionals, particularly physicians and dentists; maintaining a school system whose quality of instruction will remain stable in the face of rapidly increasing numbers of new students; and safeguarding the area water supply, which is widely feared to be inadequate for meeting projected demands. With the exception of increased prices and taxes, which have created a special hardship for those on fixed incomes, the social impact on townspeople so far has not been particularly unpalatable. Second thoughts about development are growing, however, with many questioning the desirability of supporting a third and fourth generating plant at Colstrip.

Planning for the overall impact of the generating plants and related coal development has been difficult in most instances because specific projections of future industrial activity and population growth are evidently not available or have not been made public. The Montana towns have little interest in becoming industrialized communities, and only a small number of newcomers are expected to stay for an extended period of time.

3. Newcomers

Most of the new residents are presently engaged in construction work of relatively short duration. For the most part, newcomers have not been accepted into the established social structure. They and locals tend to stay apart from each other because of their differing values, interests, and commitments. Newcomers who have common interests socialize, and some have managed to make friends with locals and become accepted. Social life for most newcomers at Colstrip is characterized by boredom, because there is little for strangers to do in a small town, especially when one has no private land requiring attention. The lack of housing and of land to buy is widespread throughout the study area, making living conditions difficult for most newcomers, who find themselves with virtually no alternative to crowded trailer parks or camp sites. There is little privacy or neighboring. They are situated like urban tourists in an unfamilir rural world.

4. Opinions of Energy Demand

Some interviewees have noted that power companies nationwide have been quick to ask for increases in rates to offset the recent trend in reduced power consumption, confirming their suspicions that the energy "demands" the companies have been citing as reason to develop Western coal are more created than real and are an excuse to seek more profits rather than to alleviate a true crisis situation. It seems that while the public is being asked to sacrifice and conserve energy, the companies feel they should be exempted from bearing any part of the hardship, least of all through reduced earnings.

Also, because so much of the energy to be generated through coal development will leave Montana, it seems as if out-of-state desires and values supercede those of persons whose life-styles are threatened by coal development. There are enormous social costs being paid by the comparatively few people ranching in southeastern Montana. It appears to many interviewees that residents elsewhere in the nation consider these costs trivial compared to the social benefits the latter will receive from the energy production activities here. Regardless of the reason, these activities have created a constantly changing situation which has generated pervasive and oppressive feelings of uncertainty and vulnerability throughout the study region. The effects are being felt in different ways by the many different groups residing in the study communities, each of which has its own distinct problems and concerns in coping with the uncertainties and insecurities associated with rapid industrialization. Aside from the schools, however, the biggest social impact to date has been upon ranchers.

B. Colstrip Regional Public Opinion

A study was undertaken to provide a broad range of information about the attitudes, opinions, and feelings of the people living in parts of Rosebud County that are significantly affected by actual and proposed energy development.

The study was designed as a survey utilizing a lengthy questionnaire administered through personal interviews. A 3% sample (179 persons) of the adult population of Rosebud County was surveyed. The sample was drawn from lists of utility customers, rental lists provided by Western Energy Company for the Colstrip area, and BLM lists of landowners. The population influx related to expanded mine production and the construction of Units 1 and 2 outdated information provided in the 1970 census and required a more comprehensive list of Rosebud County residents. The sample was also stratified by area within the county. Five categories of persons were designated for the survey, including:

1) Residents of Forsyth, Hathaway, and Rosebud in the northern part of the county,

2) Residents of Colstrip,

3) Landowners and ranch hands living south of the Yellowstone River and north of the Northern Cheyenne Reservation,

4) Residents of the Ashland area, and,

5) Residents of the area south of the Northern Cheyenne Reservation.

No interviews were conducted on the Northern Cheyenne Reservation.

A pretest of the questionnaire was made in June 1974, and appropriate modifications were made as necessary. Replies to the questionnaire began in July and continued through the first week of August 1974. Computer analysis of the survey responses was carried out in August 1974.

Caution must be used in interpreting survey results. Designed to identify respondent opinions, the survey reflects opinion at the point in time in which the questionnaire was administered. As such, some change in opinion can be expected as events occur locally, within the state, or within the nation. The important feature of survey results is not the absolute statistical numbers they provide. Rather, the general trend of opinion must be emphasized.

1. Results

One series of questionnaire items was directed to the respondents' attitudes toward the building of Units 3 and 4 and alternatives to locating additional power plants in the state. A summary of responses is located in Tables 8-11, 8-12, 8-13 and 8-14. The dominant trend is that Rosebud County residents feel there should be a delay in the construction of Units 3 and 4 until the impacts of Units 1 and 2 can be more carefully assessed or that the proposed units should not be built. Respondents indicated strong concern about the effects of Units 1 and 2 on air and water, potential industrial use of Yellowstone River water, involvement of local people in the decision-making processes affecting the development of their area, and land reclamation. Alternatives to building additional power plants in Montana emphasized the idea of stripping Montana coal for export to other areas for power plant consumption -particularly those areas where the generated electricity will be consumed.

The occupational categories of the respondents reflect clear differences of opinion. Construction workers were much more "pro-development" than were area ranchers, businessmen, and miners, as Tables 8-13 and 8-14 illustrate. This difference can probably be tied to the vested interests of the parties involved. Additional development offers the promise of job security to construction workers, while ranchers see their life-styles threatened. Miners and businessmen may have a variety of motives and are difficult to classify.

A second series of questions was directed a
respondent attitudes toward life in Colstri
(Tables 8-15, 8-16 and 8-17). Respondents suggested that a "company town" prevented the growt
of shanty towns and provided for more orderl
development of the community. However, few respondents suggested that MPC was interested i
providing a good community, at least in comparison with earning additional profits. Generally
Colstrip was not highly valued as a place t
live. Major deficiencies in the community, a
cited by respondents, were the lack of indoor an
outdoor recreational facilities, housing, an
medical care.

The anticipated impact of Units 3 and 4 o
social services brought mixed reactions. Construction workers tended to view the situatio
positively, suggesting improvement in service
with additional development. Ranchers took a
opposite view. Table 8-18 illustrates this pattern in reference to medical services. Mos
respondents suggested that building Units 3 and
would result in overcrowding area schools (Tabl
8-19). However, construction workers felt tha
the quality of education in the area woul
improve with the addition of Units 3 and 4.

2. Conclusions

Generally speaking, the residents of Rosebu
County are not in favor of additional power plan
facilities within their county. The alternativ
of stripping the coal for export is the preferre
route of development. The reasons for this pattern are many and varied but appear to primarily

TABLE 8-11

Attitudes of Rosebud Study Area Residents Toward Construction of Units 3 and 4, by Occupational Category

	Occupational Category										
	Mining	Permanent Colstrip	Construction Manual	Construction Nonmanual	Rancher Ranch Hand	Railroad Employee	Government Employee	Retired	Business	% of Total	N
Question 158. I believe that Units 3 and 4 should:											
(1) Be built unconditionally	1.1	0.6	4.5	0.6	----	----	----	----	2.2	8.9	16
(2) Be built if the state can enforce strong controls	3.4	1.7	10.6	2.8	1.1	0.6	3.9	2.8	5.6	32.4	58
(3) Not be built until the effects of Units 1 and 2 are known	3.9	1.1	5.6	0.6	7.8	1.7	5.0	2.8	10.6	39.1	70
(4) Not be built at all	----	----	0.6	----	7.8	----	0.6	1.7	2.2	12.8	23
(9) Don't know	0.6	----	2.2	----	----	0.6	----	1.2	2.2	6.7	12
Total	8.9	3.4	23.5	3.9	16.8	2.8	9.5	8.4	22.9	100.0	
N	16	6	42	7	30	5	17	15	41		179

Chi Square = 88.2541; df = 36; $p < .001$

TABLE 8-12

Attitudes of Rosebud Study Area Residents Toward Delaying Approval of Units 3 and 4

	Number of Responses	% of Total
Question 163. Units 3 and 4 should be delayed until:		
(1) A way is found to involve people who will be affected in decision-making processes	22	8.3
(2) More is known about the effects of Units 1 and 2 on air and water	68	25.6
(3) More is known about water use needs from Yellowstone River	38	14.3
(4) School facilities catch up	21	7.9
(5) More is known about the impact on Indian reservations	3	1.1
(6) More is known about social costs of Units 1 and 2	14	5.2
(7) Better living conditions are provided for construction workers	16	6.0
(8) Land reclamation is assured	31	11.6
(9) Should not be delayed	28	10.5
(10) Should not be granted	17	6.4
(11) Other response	7	2.6
Total	265*	100.0

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*Total responses exceed 179 because some respondents selected more than one answer.

TABLE 8-13

Attitudes of Rosebud Study Area Residents Toward Further Coal Development, by Occupational Category

	Occupational Category									
	Mining	Permanent Colstrip	Construction Manual	Construction Nonmanual	Rancher Ranch Hand	Railroad Employee	Government Employee	Retired	Business	% of Total	N
Question 106. Assuming that Montana is obliged to help the rest of the nation to meet growing energy needs, there remains the question of the reasonable limits of Montana's obligation. That is, how much coal development in Montana is enough, how much is too much?											
(1) There should be no further development: what we have under way is enough.	1.7	----	2.2	----	4.5	----	2.2	0.6	2.8	14.0	25
(2) Further development should be confined to mining and exporting coal.	2.2	0.6	6.1	----	8.9	1.1	3.9	2.2	6.7	31.8	57
(3) Further development should be confined to mining and mine-mouth power generation.	2.8	0.6	3.9	1.7	0.6	----	1.7	0.6	3.9	15.6	28
(4) Further development should not be restricted, but should be a direct response to what the rest of the nation says it wants.	1.1	1.7	9.5	2.2	0.6	1.1	0.6	2.2	5.0	24.0	43
(5) Don't know	1.1	0.6	----	----	----	----	1.2	2.8	3.5	10.1	18
(6) Other response	----	----	1.7	----	2.2	0.6	----	----	----	4.5	8
Total	8.9	3.4	23.5	3.9	16.8	2.8	9.5	8.4	22.9	100.0	
N	16	6	42	7	30	5	17	15	41		179

Chi Square = 98.2851; df = 54; p < .001

TABLE 8-14

Attitudes of Rosebud Study Area Residents Toward Location of Units 3 and 4 Outside of Montana, by Occupational Category

	Occupational Category										
	Mining	Permanent Colstrip	Construction Manual	Construction Nonmanual	Rancher Ranch Hand	Railroad Employee	Government Employee	Retired	Business	% of Total	N
Question 175. Units 3 and 4 should be built close to those who will use most of the electricity which these units will generate:											
(1) Strongly agree	----	----	0.6	----	7.3	----	1.1	----	2.2	11.2	20
(2) Agree	5.6	1.1	5.0	----	7.3	1.1	5.0	4.5	8.9	38.5	69
(3) Neutral	0.6	0.6	3.9	----	1.7	1.1	1.1	1.7	6.1	16.8	30
(4) Disagree	2.8	1.7	12.3	3.9	0.6	----	2.2	1.7	4.5	29.6	53
(5) Strongly disagree	----	----	1.1	----	----	----	----	----	0.6	1.7	3
(6) Don't know	----	----	0.6	----	----	0.6	----	0.6	0.6	2.2	4
Total	8.9	3.4	23.5	3.9	16.8	2.8	9.5	8.4	22.9	100.0	
N	16	6	42	7	30	5	17	15	41		179

Chi Square = 103.0300; df = 45; p < .001

TABLE 8-15

Attitudes of Rosebud Study Area Residents Toward Construction of Units 3 and 4 in a Company-Owned Town, by Occupational Category

	Occupational Category										
	Mining	Permanent Colstrip	Construction Manual	Construction Nonmanual	Rancher Ranch Hand	Railroad Employee	Government Employee	Retired	Business	% of Total	N
Question 183. It is better for the construction of Units 3 and 4 to be in a company-owned town because it prevents growth of shanty towns and development is more orderly:											
(1) Strongly agree	1.7	0.6	1.7	----	0.6	----	----	----	0.6	5.0	9
(2) Agree	5.6	1.1	12.8	2.8	7.8	1.1	5.6	5.6	10.1	52.5	94
(3) Neutral	----	----	1.1	0.6	1.1	----	2.2	----	6.1	11.2	20
(4) Disagree	1.7	1.7	5.6	0.6	5.6	1.1	1.7	1.1	4.5	23.5	42
(5) Strongly disagree	----	----	1.7	----	----	----	----	0.6	----	2.2	4
(6) Don't know	----	----	0.6	----	1.1	0.6	----	1.1	1.7	5.0	9
(7) Objected to the item	----	----	----	----	0.6	----	----	----	----	0.6	1
Total	8.9	3.4	23.5	3.9	16.8	2.8	9.5	8.4	22.9	100.0	
N	16	6	42	7	30	5	17	15	41		179

Chi Square = 59.3591; df = 30

TABLE 8-16

Attitudes of Rosebud Study Area Residents Toward Montana Power Company's Administration of Colstrip, by Area of County

	Area of County								
	Forsyth, Rosebud	Rural, East Section	Rural, West Section	Colstrip, Power Plant Side	Colstrip, Permanent Side	Ashland Area	Birney Area	% of Total	N
Question 168. The town of Colstrip is a good example for showing that Montana Power Company is more interested in providing a good community than in earning dollars:									
(1) Strongly agree	0.6	----	----	0.6	----	----	----	1.1	2
(2) Agree	6.7	----	----	1.7	3.9	1.1	0.6	14.0	25
(3) Neutral	11.7	0.6	0.6	4.5	1.7	0.6	1.1	20.7	37
(4) Disagree	21.3	1.1	3.9	8.4	5.0	1.7	1.7	43.0	77
(5) Strongly disagree	5.6	0.6	2.8	1.7	3.3	1.7	1.7	17.3	31
(6) Don't know	2.8	----	----	----	0.6	0.6	----	3.9	7
Total	48.6	2.2	7.3	16.8	14.5	5.6	5.0	100.0	
N	87	4	13	30	26	10	9		179

Chi Square = 31.1119; df = 40

TABLE 8-17

Attitudes of Rosebud Study Area Residents Toward Their Living Conditions, by Area of County

	Area of County								
	Forsyth, Rosebud	Rural, East Section	Rural, West Section	Colstrip, Power Plant Side	Colstrip, Permanent Side	Ashland Area	Birney Area	% of Total	N
Question 10. My living conditions here leave a lot to be desired:									
(1) Strongly agree	1.1	----	1.7	3.4	1.1	----	----	7.3	13
(2) Agree	8.4	----	1.1	6.1	5.6	1.7	1.7	24.6	44
(3) Neutral	2.2	----	----	1.7	1.7	----	----	5.6	10
(4) Disagree	34.1	1.7	3.9	5.0	5.1	3.9	2.2	55.9	100
(5) Strongly disagree	1.7	0.6	0.6	0.6	1.1	----	1.1	5.6	10
(6) Don't know	1.1	----	----	----	----	----	----	1.1	2
Total	48.6	2.2	7.3	16.8	14.5	5.6	5.0	100.0	
N	87	4	13	31	26	10	9		179

Chi Square = 53.6664; df = 40

TABLE 8-18

Rosebud Study Area Residents' Perceptions of the Possible Effects of Units 3 and 4 on Medical Services, by Occupational Category

	Occupational Category										
	Mining	Permanent Colstrip	Construction Manual	Construction Nonmanual	Rancher Ranch Hand	Railroad Employee	Government Employee	Retired	Business	% of Total	N
Question 196. The building of Units 3 and 4 would improve the quality and availability of medical services:											
(1) Strongly agree	0.6	----	1.1	0.6	----	----	0.6	----	0.6	3.4	6
(2) Agree	4.5	1.7	14.0	1.7	2.8	----	3.9	1.7	5.6	35.8	64
(3) Neutral	2.2	0.6	4.5	0.6	1.7	----	2.8	1.7	5.6	19.6	35
(4) Disagree	1.7	1.1	3.9	1.1	10.6	1.1	2.2	2.8	6.7	31.3	56
(5) Strongly disagree	----	----	----	----	1.1	----	----	----	0.6	1.7	3
(6) Don't know	----	----	----	----	0.6	1.7	----	2.2	3.9	8.4	15
Total	8.9	3.4	23.9	3.9	16.8	2.8	9.5	8.4	22.9	100.0	
N	16	6	42	7	30	5	17	15	41		179

Chi Square = 82.8034; df = 45; $p < .001$

TABLE 8-19

Rosebud Study Area Residents' Perceptions of Potential Crowding of Schools, by Occupational Category

	Occupational Category										
	Mining	Permanent Colstrip	Construction Manual	Construction Nonmanual	Rancher Ranch Hand	Railroad Employee	Government Employee	Retired	Business	% of Total	N
Question 193. The construction of Units 3 and 4 will cause serious crowding of the schools:											
(1) Strongly agree	1.7	0.6	2.8	----	6.1	0.6	2.8	0.6	1.7	16.8	30
(2) Agree	6.7	2.2	12.3	2.8	10.1	1.1	6.1	5.6	16.8	63.7	114
(3) Neutral	----	0.6	3.4	----	0.6	----	0.6	0.6	2.2	7.8	14
(4) Disagree	0.6	----	4.5	1.1	----	----	----	0.6	1.7	8.4	15
(5) Strongly disagree	----	----	----	----	----	----	----	----	0.6	0.6	1
(6) Don't know	----	----	0.6	----	----	1.1	----	1.1	----	2.8	5
Total	8.9	3.4	23.5	3.9	16.8	2.8	9.5	8.4	22.9	100.0	
N	16	6	42	7	30	5	17	15	41		179

Chi Square = 87.1167; df = 45; p < .001

hinge on uncertainty about the future. That is, development should be delayed or restricted until an adequate assessment can be made concerning the impacts of Units 1 and 2. Residents are also concerned about potentially deficient social services, particularly in the schools, should Units 3 and 4 be constructed. The changing life-style and social structure of the area was also an issue of importance, particularly to ranchers.

C. State-wide Public Opinion Survey

During August 1974, the Department initiated a state-wide public opinion survey. The survey was designed to provide information concerning the Montana public's viewpoints of energy-related issues. Attitudes were examined in five general areas: 1) Strip mining, 2) High voltage electric transmission lines, 3) Coal-fired power plants, 4) Industrial development of the state, and 5) Public information concerned with the issues of coal development and electric utility construction.

A total of 2,200 questionnaires were mailed to Montana adults whose names were selected at random from voter registrations, tax rolls, and telephone directories. The questionnaire was distributed in two formats, with each half of the sample receiving one version of the questionnaire. In some items, respondents were asked to rate their opinion of the statement on a scale of responses ranging from "Strongly Agree" to "Strongly Disagree". Ordinal ranking scales in which respondents ranked items from 1 to 5, short answer, fill-in-the-blank, forced choice questions, and a series of demographic (personal history) questions completed the questionnaire.

A total of 796 questionnaires, or 36.2%, were returned. However, with adjustment made for unusable questionnaires such as those returned unopened by the Postal Services, the number of usuable questionnaires fell to 778, reflecting a response rate of 35.4%. A mailed follow-up letter was distributed in the second week of September, and approximately 150 additional questionnaires were subsequently returned. The analysis for this report considers only those 778 questionnaires received prior to the follow-up. Analysis of the remainder is continuing and will be provided in the final EIS.

The following tables summarize the results of the survey. For the purpose of brevity only those items dealing explicitly with power plants or high voltage transmission lines are considered. All figures expressed in the tables are percentages with the exception of a figure marked "total N" that indicates the number of persons responding to the question.

In reading the tables it is important to bear in mind that public opinion surveys measure opinion at one point in time. Duplicating the survey would most likely result in a shift in the results presented, as often happens in pre-election political preference polls. Emphasis should not be placed on absolute scores. Rather, the trend of opinion is the major factor to consider, for scores change more readily than do trends. Finally, caution should be exercised in attempting to generalize the findings of this survey to the public-as-a-whole. Questionnaire respondents were disproportionately male, between the ages of 25-54, well educated, with professional or technical occupations, and with earnings exceeding $10,000 per year. It is also important to note, however, that the well educated and affluent tend to be the opinion leaders in an urbanized society such as the United States. A summary of the respondents' personal backgrounds is presented in Table 8-20.

1. Results

Attitudes toward coal-fired power plants were more negative than those toward transmission lines. The response to all questions dealing with power plants is tabulated in Table 8-21.

a. Locations

Respondents do not favor the construction of coal-fired power plants in Montana (52.0%). Approval of power plants was indicated by 29.3%. A clear majority (65.6%) expressed the desire not to live in an area where coal-fired power plants are located. Respondents modestly agreed with an item suggesting that agriculture and power plants can co-exist in the same area (41.1%). An item suggesting that power plants be built at locations currently industrialized met with approval (50.8%). A clear majority (59.6%) indicated that power plant construction was acceptable provided strong environmental safeguards exist to protect the land, air, water, and lifestyle of Montana residents.

Respondent preferences with regard to alternatives for energy development were clearly expressed. Seventy percent (70.0%) opposed the construction of coal-fired power plants in Montana when the electricity is to be shipped elsewhere. Strong majorities suggested that if Montana coal is needed to generate electricity, the coal should be transported to the requisite area (60.6%), and power plants should be built in the areas where the electric power will be consumed (68.2%).

b. Costs

Questions seeking opinions about who should pay the social and environmental costs associated with power plant construction were met with a mixed response. Respondents split on the idea of the electrical consumer paying such costs, with 47.7% approving, 40.0% disapproving, and 11.3% holding neutrality. However, strong majorities suggested the power companies absorb the social and environmental costs associated with power plant construction (73.5%) and that utility companies pre-pay such costs (75.3%).

c. Economic Effects

The argument that industrial development

TABLE 8-20

MONTANA ENERGY SURVEY

SAMPLE DESCRIPTION

SEX

MALE	FEMALE	NOT SPECIFIED
73.7%	23.1%	3.2%

TOTAL N = 778

AGE

15 - 24 years	7.7%	55 - 64 years	11.4%
25 - 34 years	26.7%	65 - 74 years	3.3%
35 - 44 years	20.6%	75 or more years	1.3%
45 - 54 years	25.3%	Not Specified	3.6%

TOTAL N = 778

EDUCATION

3.5%	Elementary School (8 years or less)
4.6%	Some High School
17.1%	High School Graduate
25.8%	Some College
20.2%	College Graduate
25.7%	Graduate or Professional Training
3.1%	Not Specified

TOTAL N = 778

TABLE 8-20 (Cont.)

MONTANA ENERGY SURVEY

SAMPLE DESCRIPTION

OCCUPATION

33.7%	Professional, Technical, and Kindred Workers
9.4%	Business, Managers and Administrators
8.1%	Clerical and Sales Workers
5.3%	Craftsmen and Foremen
16.5%	Operatives and Services Workers
5.8%	Homemakers
7.2%	Agriculture; Farm Owners, Managers and Workers
4.5%	Retired
9.5%	Unemployed, Student, Occupation not specified.

TOTAL N = 778

NATIVE BORN MONTANAN

YES	NO	NOT SPECIFIED
19.3%	77.6%	3.1%

TOTAL N = 778

LENGTH OF RESIDENCE IN MONTANA

1.4%	Less than one year
27.3%	One - Five years
15.8%	Six - Ten years
11.4%	Eleven - Fifteen years
15.4%	Sixteen - Twenty-five years
25.9%	More than Twenty-five years
2.8%	Not Specified.

TOTAL N = 778

TABLE 8-20 (Cont.)

MONTANA ENERGY SURVEY

SAMPLE DESCRIPTION

RACE

Caucasian	American Indian	Other	Not Specified
94.5%	1.3%	0.8%	3.4%

TOTAL N = 778

POLITICAL AFFILIATION

Democrat	Republican	Independent	Other	Not Specified
27.9%	24.2%	38.4%	4.9%	4.6%

TOTAL N = 778

ANNUAL FAMILY INCOME

2.6%	Less than $2,999
5.0%	$3,000 - $4,999
9.3%	$5,000 - $6,999
13.8%	$7,000 - $9,999
26.2%	$10,000 -$14,999
26.7%	$15,000 -$24,999
11.3%	$25,000 plus
5.1%	Not Specified

TOTAL N = 778

TABLE 8-20 (Cont.)

MONTANA ENERGY SURVEY

SAMPLE DESCRIPTION

PLACE OF RESIDENCE

17.6%	City greater than 50,000 population
25.1%	City, population from 10,000 - 49,999
15.7%	City, population from 2,500 - 9,999
13.1%	City or town less than 2,499
16.8%	Rural - Farm or Ranch
5.3%	Suburban Lot
2.3%	Other
4.1%	Not Specified

TOTAL N = 778

LOCATION OF RIGHT-OF-WAY ON PROPERTY

YES	NO	NOT SPECIFIED
16.5%	74.0%	9.5%

TOTAL N = 778

TYPE OF RIGHT-OF-WAY

2.2%	Railroad
6.3%	Highway
5.9%	Pipeline
15.5%	Power Line

TOTAL N = 778

TABLE 8-21

MONTANA ENERGY SURVEY

Power Plant

I favor the construction of coal burning electric generating power plants in Montana.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
7.1%	22.2%	17.7%	23.2%	28.8%
No Response 0.9%		Total N[1] = 423		

I would have no objection to living in an area where coal burning electric power plants are located.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
4.9%	17.7%	10.9%	23.4%	42.2%
No Response 0.9%		Total N = 778		

Coal burning electric power plants and agriculture can co-exist side-by-side in the same area.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5.4%	35.7%	23.2%	18.7%	14.2%
No Response 2.8%		Total N = 423		

If coal burning electric power plants are to be built in Montana, it is best to locate the plants in areas already used for industrial purposes.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
10.4%	40.4%	18.4%	24.8%	3.8%
No Response 2.1%		Total N = 423		

Construction of coal burning electric power plants is acceptable if strong environmental safeguards are provided to protect the land, air, water, and lifestyle of Montana residents.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
21.3%	38.3%	8.5%	17.3%	13.0%
No Response 1.7%		Total N = 423		

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[1] N = Total number responding to this question.

TABLE 8-21 (cont.)

Power Plant

The consumers of electricity should bear the social and environmental costs associated with the construction and operation of coal burning electric power plants.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
14.4%	33.3%	11.3%	25.1%	14.9%
No Response 0.9%		Total N[1] = 423		

If a power company wishes to construct a coal burning electric power plant, it should not be required to pay the additional cost of providing schools, sewers, roads, recreational facilities, etc. in the area.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1.9%	13.2%	9.5%	31.4%	42.1%
No Response 1.9%		Total N = 423		

If a power company wishes to construct a coal burning power plant, it should be required to pre-pay the additional cost of providing schools, sewers, roads, recreational facilities, etc. in the area.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
32.9%	32.4%	15.8%	14.7%	2.4%
No Response 1.9%		Total N = 423		

The taxes generated by the construction and operation of power plants and electric transmission lines will result in a lessening of the tax load paid by other Montana citizens.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
4.8%	23.2%	14.8%	36.1%	19.6%
No Response 1.5%		Total N = 777		

[1] N = Total number responding to this question.

TABLE 8-21 (cont.)

Power Plant

Encouraging the construction and operation of power plants and electric transmission lines would be a wise step toward providing future generations of Montanans with job opportunities.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
7.5%	31.2%	16.0%	27.7%	16.1%
No Response 1.5%		Total N[1] = 777		

I oppose the construction of coal burning electric power plants in Montana when the electricity is largely shipped to other states.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
45.7%	24.3%	7.1%	15.8%	5.8%
No Response 1.3%		Total N = 778		

If Montana coal is needed for the generation of electricity, the coal should be transported to the areas where the electricity is needed.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
27.0%	33.6%	13.7%	18.4%	5.9%
No Response 1.4%		Total N = 423		

Coal burning electric power plants should be built in the areas where the electric power will be consumed.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
24.6%	33.6%	15.6%	20.9%	3.6%
No Response 1.6%		Total N = 422		

---

[1] N = Total number responding to this question.

TABLE 8-21 (cont.)

Power Plant

Montana needs the electricity from the proposed coal burning electric generating plants to be located at Colstrip, Montana.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
6.6%	26.2%	23.2%	28.6%	13.2%

No Response 2.1% Total N[1]= 423

If additional coal burning electric power plants are built at Colstrip, Montana, I would expect electric rates to:

19.2%	Decrease
33.3%	Stay about the same
29.1%	Increase
9.9%	I wouldn't be affected because I receive electricity from a company that is not involved with the Colstrip project.
4.2%	Undecided
0.3%	I don't have electricity.

No Response 4.0% Total N = 354

[1] N = Total number responding to this question

lessens the tax load for the citizenry was not accepted by the respondents - at least insofar as it applied to power plants. A majority (55.7%) disagreed with the suggestion that tax relief comes in the form of utility construction. Respondents were split on the issue of whether power plant and utility construction was a wise step toward providing future generations of Montanans with job opportunities. Agreement was voiced by 38.7%, disagreement by 43.8%, and neutrality by 16.0%.

d. Need

Respondents split in their opinion of whether Montana needs the electricity from the proposed generating units at Colstrip. Slightly more disagree (41.8%), although 32.8% saw a need for the units. Almost 25% of the respondents took a neutral position.

c. Electrical Rates

Respondents generally felt the Colstrip units would affect electrical rates. One third (33.3%) of the respondents suggested rates would stay about the same, 29.1% thought rates would increase, and 19.9% envisioned a decrease.

2. Conclusions

The general pattern of opinion reflects the desire that power plants not be built in Montana. Respondents express little desire to live in areas where power plants are located and, if given alternatives to building power plants in the state, would prefer to see the plants located in areas where the electricity will be consumed.

D. Comparison of Public Opinion Surveys

The two public opinion surveys summarized in this report were designed to serve different purposes. The regional survey conducted in Rosebud County was intended to examine, in detail, how people feel about the area in which they live and work, opinions regarding energy development, and the impact of energy development on life in Rosebud County. The state-wide survey probed opinions toward strip mining, the construction and operation of coal-fired power plants and high voltage transmission lines, industrial development, and public information concerned with energy development in Montana. This difference in focus necessarily limits comparison between the two surveys. However, responses to some questions, principally those regarding power plant construction, can be compared.

Respondents to the regional public opinion survey appear to favor the construction of coal-burning power plants more than do respondents to the state-wide survey. However, the large number of construction workers in the regional survey has a definite effect on the degree to which the construction of power plants is favorably viewed (See Table 8-22). The most prevalent position taken by Rosebud County respondents was to make

TABLE 8-22

SURVEY RESPONSE COMPARISON-CONSTRUCTION OF POWER PLANTS

Regional Survey

Question: I believe that Units 3 and 4 should:	% of Total
(1) Be built unconditionally	8.9
(2) Be built if the state can enforce strong controls	32.4
(3) Not be built until the effects of Units 1 and 2 are known	39.1
(4) Not be built at all	12.8
(5) Don't know	6.7

N[1] = 179

Adjusted to Exclude Construction Workers

Question: I believe that Units 3 and 4 should:	
(1) Be built unconditionally	5.4
(2) Be built if the state can enforce strong controls	26.1
(3) Not be built until the effects of Units 1 and 2 are known	45.2
(4) Not be built at all	16.9
(5) Don't know	6.2

N[1] = 130

---

[1] N = Number of respondents

TABLE 8-22 (cont.)

State-Wide Survey

Question: I favor the construction of coal-burning electric generating power plants in Montana.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
7.1%	22.2%	17.7%	23.2%	28.8%

No Response 0.9%

N[1] = 423

Question: Construction of coal-burning electric power plants is acceptable if strong environmental safeguards are provided to protect the land, air, water, and lifestyle of Montana residents.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
21.3%	38.3%	8.5%	17.3%	13.0%

No Response 1.7%

N[1] = 423

---

[1] N = Number of respondents

their acceptance of the construction of the power plants subject to certain conditions, such as enforcement of strong environmental controls (32.4%) or delay until the effects of Units 1 and 2 could be assessed (39.1%). Respondents, state-wide, also favored strong environmental safeguards (59.6%). When construction workers are subtracted from the regional sample, the percentage of respondents stipulating conditions to power plant construction holds about constant (71.3% versus 71.5%), but the percentage of those favoring unconditional construction of Units 3 and 4 is diminished by 39% (5.4% versus 8.4%), and support for the idea of not building the plants at all is strengthened (16.9% versus 12.8%).

A question used on both the regional and state-wide surveys asking respondents their opinions of different alternatives for energy development in Montana met with similar response. The most favored alternative was to mine Montana coal for export (Table 8-23). Again, the influences of the presence of large numbers of construction workers in the regional survey is apparent. Construction workers contributed almost half the responses favoring unrestricted energy development.

Respondents to both surveys indicated agreement with the idea of locating power plants near electric load centers (Table 8-24). Respondents to the state-wide survey revealed a stronger pattern of agreement to these items than those in the Rosebud County survey, but again, the responses of construction personnel tended to offset the responses of the indigenous population of the county.

Respondents to both surveys suggested that agriculture and coal-burning power plants could exist side-by-side (Table 8-25). Respondents in Rosebud County were more apt to take this position than those in the state-wide sample, but, again, responses from construction personnel weighed heavily in directing the regional survey response in that direction.

Wide agreement was also indicated by respondents of both surveys as to who should bear the financial costs associated with economic development. The costs referred to are those associated with providing local social services, such as law enforcement, public health, and educational services. "Industry" and "The people who directly benefit from the power produced by the coal development" were frequently cited (Table 8-26).

The final items under consideration deal with the effect of coal-fired power plants on taxation. In the regional survey, respondents ascertained how taxes would be affected if Units 3 and 4 were built. The state-wide survey asked a similar question, though Units 3 and 4 were not mentioned. In general, respondents did not see the construction and operation of power plants as a source of tax relief. Rosebud County respondents suggested that taxes would probably rise (Table 8-27).

TABLE 8-23

SURVEY RESPONSE COMPARISON-MONTANA'S ENERGY OBLIGATION

Question: Assuming that Montana is obliged to help the rest of the nation to meet growing energy needs, there remains the question of the reasonable limits of Montana's obligation. That is, how much coal development in Montana is enough, how much is too much?

State-Wide Survey N^1 = 778	Regional Survey N^1 = 179	
24.6%	14.0%	There should be no further development; what we have underway is enough.
32.6%	31.8%	Further development should be confined to mining and exporting coal.
20.8%	15.6%	Further development should be confined to mining and mine-mouth coal-burning electric power plants.
11.7%	24.0%	Further development should not be restricted, but should be a direct response to what the rest of the nation says it wants.
10.3%	14.6%	Don't know, no response, other response.

[1] N = Number of respondents

TABLE 8-24

SURVEY RESPONSE COMPARISON-LOCATION OF POWER PLANTS

State-Wide Survey

Question: I oppose the construction of coal burning electric power plants in Montana when the electricity is largely shipped to other states.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
45.7%	24.3%	7.1%	15.8%	5.8%

No Response 1.3%
N[1] = 778

Question: If Montana coal is needed for the generation of electricity, the coal should be transported to the areas where the electricity is needed.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
27.0%	33.6%	13.7%	18.4%	5.9%

No Response 1.4%
N[1] = 423

Question: Coal burning power plants should be built in the areas where the electric power will be consumed.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
24.6%	33.6%	15.6%	20.4%	3.6%

No Response 1.6%
N[1] = 422

[1] N = Number of respondents

TABLE 8-24 (cont.)

Regional Survey

Question: Units 3 and 4 should be built close to those who will use most of the electricity which these units will generate.

Strongly Agree[2]	Agree	Neutral	Disagree	Strongly Disagree
11.2%	38.5%	16.8%	29.6%	1.7%

Don't Know 2.2%

N[1] = 179

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[1] N = Number of respondents

[2] Construction personnel account for 5.6% of those responding strongly agree or agree, 3.9% of those responding neutral, and 17.3% of those responding disagree or strongly disagree. N = 49

TABLE 8-25

SURVEY RESPONSE COMPARISON-INFLUENCE OF POWER PLANTS ON AGRICULTURE

State-Wide Survey

Question: Coal-burning electric power plants and agriculture can co-exist side-by-side in the same area.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5.4%	35.7%	23.2%	18.7%	14.2%

No Response 2.8%

N[1] = 423

Regional Survey

Question: It is likely that four power generating units and the related strip mining activities could operate in this area without harmfully affecting existing ranching operations.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
6.1%	45.3%	16.2%	21.8%	8.4%

Don't Know 2.2%

N[1] = 179

[1] N = Number of respondents

TABLE 8-26

SURVEY RESPONSE COMPARISON-RESPONSIBILITY FOR LOCAL ECONOMIC COSTS

Question: In general, and as a rule, who should pay the local economic costs of industrialization of coal resources (i.e. expansion of law enforcement, public health, and educational services).

State-Wide Survey	Regional Survey	
N[1] = 778	N[1] = 179	
23.9%	21.8%	Industry
4.4%	2.8%	Local Government
2.3%	5.6%	State Government
2.4%	2.8%	Federal Government
21.1%	16.8%	The people who directly benefit from the power produced by the coal development.
33.3%	34.6%	All of the above
2.1%	3.4%	None of the above
10.5%	12.3%	No response, don't know, some combination other than listed above.

[1] N = Number of respondents

TABLE 8-27

SURVEY RESPONSE COMPARISON-EFFECT OF POWER PLANT CONSTRUCTION ON TAXATION

Regional Survey

Question: If Units 3 and 4 are constructed, my taxes probably will:

(1) Go down substantially	1.1%
(2) Go down slightly	10.6%
(3) Be unaffected	27.9%
(4) Go up slightly	33.0%
(5) Go up substantially	19.0%
(6) Don't know	8.4%

N[1] = 179

State-Wide Survey

Question: The taxes generated by the construction and operation of power plants and electric transmission lines will result in a lessening of the tax load paid by other Montana citizens.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
4.8%	23.2%	14.8%	36.1%	19.6%

No Response 1.5%

N[1] = 777

---

[1] N = Number of respondents

While the two surveys examined opinions of different populations and often concerned themselves with different topics, the preceding items illustrate comparable levels of agreement on a series of major questions focused at power plant construction, especially where responses from the transient construction population are held constant and the established population of Rosebud County is compared with Montanans across the state. Both surveys indicate a preference for not building power plants in the state, but, if built, conditioning the construction and operation of the plants with strong environmental safeguards. Respondents also demonstrated a preference for exporting Montana coal rather than building mine-mouth generating plants. Both surveys point to industry and the consumers of the generated electricity as having a major responsibility for paying the local economic costs of coal industrialization. Industrialization of coal resources is not viewed as an avenue to tax relief for Montanans.

8.2.2.3. Social Services in Rosebud County

A. Inventory

A review of social service delivery systems was conducted in Rosebud County during the spring and summer of 1974. This review was an effort to ascertain the current disposition of social services within the area and to project the impact of the construction and operation of Units 3 and 4 on existing social service delivery systems.

1. Health Care

A new 26-bed hospital located in Forsyth is adequately serving the needs of the city and county. Colstrip is served by a first aid station set up in a mobile home and staffed 10 to 12 hours per day by two registered nurses. The Indian population is served by an out-patient clinic located at Lame Deer and operated by the Indian Health Service.

Three physicians (MD's) are located in Forsyth, and two are in Lame Deer with the Indian Health Service. Presently the number of MD's is inadequate for the white population of the county. Public Health nurses operate from Forsyth and Lame Deer, with two Western Energy Company (WECO) registered nurses serving Colstrip.

A county ambulance is located in Forsyth. WECO operates an ambulance service from Colstrip, with the Indian Health Service providing ambulance service for the reservation area.

A 39-bed wing attached to the hospital in Forsyth is the only retirement and nursing facility in the county. Mental health services for the county are provided by the Eastern Montana Mental Health Center, with a full time psychologist located in Forsyth. This individual also serves Powder River and Treasure Counties. One psychiatric nurse is attached to the Indian Health Service Clinic at Lame Deer.

2. Welfare

Rosebud and Treasure Counties operate a combined county welfare department. The five-person staff is headquartered in Forsyth, with a branch office in Lame Deer. Welfare services in the Northern Cheyenne Reservation area are supplemented by the Welfare Office of the Bureau of Indian Affairs.

3. Fire Protection

Volunteer fire departments are located in Forsyth, Colstrip, and Lame Deer. The Rosebud County Sheriff's Department and U.S. Forest Service provide fire protection in rural areas. Generally, county fire protection is deficient. The inadequacies vary with the community, but additional equipment, facilities to house fire apparatus, and trained men are needed.

4. Law Enforcement

The Rosebud County Sheriff's office is the main law enforcement agency within the county. The 10-member department is headquartered in Forsyth, with two deputies stationed in Colstrip, one in Ashland, and one in Birney. Two State Highway patrolmen operate from Forsyth, primarily patrolling Interstate 94. An 11-member tribal police force is stationed in Lame Deer to serve the entire Northern Cheyenne Reservation.

At present, Colstrip has inadequate police protection given the size of its resident population. Cross deputization of the Indian Police force with Rosebud County would improve law enforcement in the southern part of the county. The tribal police force now has jurisdiction only over the Indian people, although non-Indians can be detained until the sheriff's department can be summoned to take responsibility.

5. Transportation

Three major roads cross the county: (1) Interstate 94, traveling east-west, crosses the northern portion of the county along the Yellowstone River through Forsyth; (2) U.S. 212 crosses the southern portion of the county through Ashland and Lame Deer in an east-west direction; and (3) Highway 315 links U.S. 212 with Interstate 94, providing a north-south corridor from Forsyth to Lame Deer via Colstrip.

An increased volume of traffic on Highway 315 has greatly hastened its deterioration, and the State Highway Department anticipates a major effort to reconstruct and imporve the facility. City streets in Forsyth and Colstrip are generally in disrepair and in need of attention.

Public transportation is provided through Forsyth (east-west) by Greyhound Bus Lines and Amtrak. A commuter bus is providing daily service between Colstrip and Forsyth. The county is not served by scheduled commercial air carriers, although a small airport is located at Forsyth.

6. Water and Sanitation

Forsyth and Colstrip are currently operating water supply facilities at maximum capacity, and population growth will require major additions to existing water systems. A similar situation prevails in Lame Deer.

Sanitation systems in Forsyth and Colstrip are grossly inadequate. Additional sewage lagoons must be constructed to bring the sewage disposal system up to standard.

7. Schools

The population influx associated with the construction of Units 1 and 2 has severely strained the school capacity of the county. In Colstrip modular classrooms and a system of double-shifting students were used during the 1973-1974 school year to accommodate increases in school enrollment. Additional modular classrooms are being provided by MPC, but expansion of permanent facilities is requisite.

Schools in Forsyth have also experienced increases in enrollment, but a general condition of excess capacity (due to past population decline and the availability of an unused parochial school) has allowed the school system to absorb recent enrollment growth. However, continued population growth will require additions to the Forsyth School District.

8. Housing and Commercial Services

Housing is at a premium throughout the county, and the price of housing (to rent or purchase) has steadily increased.

Generally, housing in Forsyth is below average in quality. Relatively few new residential or commercial structures have been added, but trailer parks have absorbed a large number of residents.

In Colstrip all permanent housing is owned by Western Energy Company. This includes approximately 60 homes purchased from the Northern Pacific railroad, nine 4-plexes, and 20 single family dwellings constructed since 1972. Permanent dwellings are generally adequate.

Trailer parks can accommodate over 160 units, but conditions in trailer parks are of low quality. Western Energy Company has made little attempt to upgrade the quality of service in the trailer parks occupied by temporary construction workers.

The population boom has not resulted in a related building boom outside of Colstrip. WECO is continuing to add both housing and commercial facilities.

B. Impacts

The impacts of Units 1 and 2 on social service delivery systems are already being felt in Rosebud County. Construction of Units 3 and 4 can be expected to exacerbate current impacts.

At the present time Rosebud County is deficient in health care personnel (particularly physicians), lacks adequate fire protection in the urbanized areas, needs additional water and sanitary facilities, faces a condition of severe overcrowding in its educational institutions, and lacks adequate housing both in quantity and quality. The following tables (8-28, 8-29, and 8-30) summarize the existing conditions of Rosebud County's social services and the projected demand for such services in the future. The tables are based on population estimates presented in Section 8.2.2.1. Social service needs are calculated by estimating the county population and applying an adequacy standard for each social service. For example, in 1980, Rosebud County will have a projected population of 7,862 (With Units 1 and 2) or 9,374 (With Units 1-4). The adequacy standard for primary-care physicans is one medical doctor per 1,222 persons. Thus, in 1980 the county will need 7 primary-care physicians. While the tables illustrate an actual as well as a potential deficiency in many areas, two must be singled out for emphasis.

1. School Facilities

Construction of Units 3 and 4 would add an increase of almost 100% to demands for school facilities by 1978 (See Table 8-30 for estimated school populations). Given the size of this demand, the reluctance of Western Energy Company to provide permanent facilities, and the relatively small portion of taxes paid by construction personnel for support of school facilities, Rosebud County property owners must face the possibility of large tax increases for school construction or a serious decline in educational quality due to overcrowding.

2. Housing

Housing provides an equally bleak forecast. Assuming approximately three and a half residents per housing unit, the estimated 1978 requirement calls for an addition of 1,662 units. In 1970 the county contained slightly more than 1,800 occupied housing units.

By 1980, with the completion of power plant construction, additional housing demand will drop to approximately 950 units. The proposal in the Colstrip Plan to have 529 household units available in 1980 will not meet this influx. The estimated housing shortage is approximately 400 units, and, given the limitations of the population estimates, perhaps greater.

TABLE 8-28

PROJECTION OF ROSEBUD COUNTY SERVICE NEEDS

		PROJECTED NEEDS						
SERVICE	ACTUAL 1974[1]	1975	1978	1980	1985	1990	1995	2000
Doctors - Primary Care[4]	5[5]	6[2](2)[3]	7(3)	7	8	8	9	10
Doctors - Specialty Care[6]	0	5 (1)	6(2)	6	7	7	7	8
Dentists[7]	1	4 (1)	4(2)	4	5	5	6	6
Hospital Beds[8]	26	29 (8)	34(13)	35(2)	38	41	45	49
Beds for Elderly[9,10]	39	27	27	27	27	28	27	27
Home Health Care Vists to the Elderly[10,11] (perweek)	NA[12]	120	120	121	122	126	126	120
Law Officers[13]	23[14]	14 (4)	17(7)	18(1)	19	20	22	25
Police Cars[15]	16[16]	4 (1)	4(2)	4	5	5	6	6
Sanitary Fill[17] (acres)	NA	29 (8)	24(13)	35(2)	38	41	45	49
Teachers and classrooms[18]	100[19]	117(35)	145(54)	150(8)	157	169	184	203

NA = Not Available
Footnotes for this table are on the following pages

Footnotes for Table 11-107

1) The services for 1974 are those which were actually provided. Service needs for all other years are based upon the population forecasts.

2) Figures have been rounded off to the nearest whole unit.

3) Figures for base needs of operating personnel, secondary service personnel, families and/or long-term residents appear outside parentheses. Figures for construction-related needs appear in parentheses.

4) Adequacy Standard: 1 Doctor: 1,222 population.
Source: Medical Economics Magazine, cited by Montana Department of Health and Environmental Science 1973.

5) This includes two Public Health Physicians assigned to the Northern Cheyenne Reservation.

6) Adequacy Standard: 1 Doctor: 1,508 population.
Source: Medical Economics Magazine, cited by Montana Department of Health and Environmental Science 1973.

7) Adequacy Standard: 1 Dentist: 2,000 population.
Source: U.S. Department of Agriculture, publication ERS 465, p.9.

8) Adequacy Standard: 4 beds: 1,000 population.
Source: Based on the national average of 1,183 patient-days per year per thousand of population multiplied by about 82% average occupancy rate for each hospital. These figures lead to a projected need of four hospital beds per thousand of population.

The projections of hospital bed needs do not consider a variety of variables which must be considered by local planners in projecting actual local hospital needs. Not considered are the following factors: the availability of other regional facilities, the frequency of need of local people to travel to larger hospitals which can provide more specialized services, the availability of doctors and other health care personnel at the local level, the availability of good ambulance and other patient transfer facilities, providing improved access to other regional medical facilities, and the desirability of building satellite ambulatory care centers in smaller cities and concentrating high quality in-patient services in the larger cities. These questions are beyond the scope of this study and need to be considered by comprehensive regional planning groups.

Projections include reservation population and therefore include hospital beds which will need to be provided on the reservations as well as those needed off the reservation. Since a clinic at Lame Deer on the Northern Cheyenne Reservation could possibly be built to serve non-Indian population, this could affect the utilization of other hospital facilities at Crow Agency, Forsyth, Miles City, and possibly even Billings and Sheridan, depending on the facility's capabilities.

9) Adequacy Standard: Based on Montana State minimum use rate of 9,116 patient days per year (1973) for patients over the age of 65 requiring skilled, personal or intermediate nursing.
Source: Montana State Department of Health and Environmental Sciences.

10) It is assumed that construction-related personnel and permanent operating, mining and services personnel associated with the mining and plant operations at Colstrip will not contain individuals over the age of 65.

11) Adequacy Standard: 2 visits per week to 10% of the population over 65.
Source: Montana State Department of Health and Environmental Sciences, Division of Comprehensive Health Planning, Home Health Care, January 1974. Cited by permission.

12) There is a public health nurse at Forsyth who visits the elderly although most of her time is spent handling other responsibilities.

13) Adequacy Standard: 1 Officer: 500 population.
Source: National and Wyoming averages, cited in Intermountain Planners and Werth-Berger Associates, Powder River Basin Capital Facilities Study for the Wyoming Department of Economic Planning and Development, p. 52.

14) This total includes two State Highway Patrolmen, an eleven-member Northern Cheyenne Tribal Police Force and a ten-member County Sheriff Department. The Sheriff's Department includes the Sheriff and Under Sheriff, four Deputies at Forsyth, two at Colstrip and one each at Birney and Ashland.

15) Adequacy Standard: 1 car: 2,000 population.
Source: National and Wyoming averages, cited in Intermountain Planners and Werth-Berger Associates, Powder River Basin Capital Facilities Study for the Wyoming Department of Economic Planning and Development, p 52. Standards range from 1 car: 2,000 population to 1 car: 3,000 population. Low population density of Rosebud County makes the former preferable.

16) This includes two State Highway Patrol cars, seven vehicles (six cars and one pick-up) for the Northern Cheyenne Tribal Police Force, and seven cars for the County Sheriff Department.

17) Adequacy Standard: 4 acres: 1,000 population.
Source: De Chiara, Joseph and Lee Koppelman, Planning Design Criteria, Van Nostrand Reinhold Company 1969, p. 320.

18) Adequacy Standard: 1 teacher: 18.2 children.
Source: GPO publication DHEW(OE) 73-11402 by Bettey Foster, cited in Intermountain Planners and Werth-Berger Associates. Powder River Basin Capital Facilities Study for the Wyoming Department of Economic Planning and Development, p 35.

It is assumed here that there will be one teacher per classroom, thus projected numbers of classrooms needed is the same as projected numbers of teachers needed. Because of the temporary nature of much of the population with the likelihood of temporary units being used, we have not attempted here to project space needs in permanent units, nor non-teaching school personnel needs.

Projections here assume that all those of school age will attend; this will probably not be the case; thus, the projections may be slightly inflated.

19) This is the total number of certified staff personnel employed by the school districts in the county, as listed in the 1973-74 Montana Education Directory, Superintendent of Public Instruction, Helena, MT.

TABLE 8-29

MUNICIPAL NEEDS BASED ON ILLUSTRATIVE[1] DISTRIBUTIONS OF PERMANENT ROSEBUD COUNTY POPULATIONS

Category of Service	Existing Facilities (1974)	Low Impact on Colstrip[2] - Year - 1980	Low Impact on Colstrip[2] - Year - 1985	High Impact on Colstrip[3] - Year - 1980	High Impact on Colstrip[3] - Year - 1985
Water Supply[4] (hundreds of acre feet per year)					
Colstrip	6[5]	5	5	7	8
Forsyth	24[6]	5.6	7	4.6	5
Lame Deer	2[7]	2.4	3	2.4	2.6
Water Treatment[8] (millions of gallong per day)					
Colstrip	1.5	1.3	1.3	1.8	2.1
Forsyth	1.5	1.4	1.8	1.2	1.3
Lame Deer	.9	.6	.8	.6	.7
Lagoon Acreage[10]					
Colstrip	11	25	25	35	40
Forsyth	8	28	35	23	25
Lame Deer	10	12	15	12	13
Teachers & Classrooms[11]					
Colstrip	26[12]	41	41	58	66
Forsyth	34	46	58	38	41
Lame Deer	18[13]	20	25	20	21

Footnotes for this table are on the following page.

Footnotes for Table 11-108

1) These service projections are based on the illustrative permanent population distributions shown and explained in Section 11.2.2.1. of this report.

2) This alternative assumes: 1) that the Western Energy Company will limit the population of Colstrip to 2500 people, resulting in a high population increase at Forsyth and a moderate increase at Lame Deer; and 2) that out-migration from rural areas in the county will occur.

3) This alternative assumes: 1) that major coal-related population increases will be concentrated at Colstrip; 2) that moderate population increases will occur in Forsyth and Lame Deer; and 3) that out-migration from rural areas of the county will occur.

4) Adequacy Standard: .20 acre-feet per person per year.
Source: Wyoming State Engineer's Office, cited in Intermountain Planners and Werth-Berger Associates, Powder River Basin Capital Facilities Study for the Wyoming Department of Economic Planning and Development, p 31.

5) Based on a figure of 350 gallons per minute from 4 wells.

6) Based on a pumping capacity of 1,500 gallons per minute from the Yellowstone River to the treatment plant.

7) Based on a pumping capacity of 45 gallons per minute for each of three wells.

8) Adequacy Standard: 517.5 gallons per day per person.
Source: Wyoming State Engineer's Office, cited in Intermountain Planners and Werth-Berger Associates, Powder River Basin Capital Facilities Study for the Wyoming Department of Economic Planning and Development, p 31.

9) The water supply at Lame Deer is well-water that tests pure and does not require treatment.

10) Adequacy Standard: 1 acre per 100 population.
Source: Montana State Department of Health and Environmental Science.

11) Adequacy Standard: 1 teacher to 18.2 children.
Source: GPO publication DHEW (OE) 73-11402, by Bettey Foster, cited in Intermountain Planners and Werth-Berger Associates, Powder River Basin Capital Facilities Study for the Wyoming Department of Economic Planning and Development, p. 35.

It is assumed that there will be one teacher per classroom, thus projected numbers of classrooms needed is the same as projected numbers of teachers needed. Because of the temporary nature of much of the population, with the likelihood of temporary units being used, we have not attempted here to project space needs in permanent units, nor non-teaching school personnel needs.

These education needs have been computed on the assumption that 30% of the illustrative permanent population will be school age and will attend school.

12) These are the number of certified staff personnel employed by the school districts of Colstrip, Forsyth and Lame Deer, as reported in the 1973-74 Montana Education Directory.

13) Since Lame Deer does not have a high school, this figure represents only the number of certified staff in the existing grade school.

TABLE 8-30

ESTIMATED SCHOOL AGE POPULATION (5-17) IN ROSEBUD COUNTY[1]

	1975	1978	1980	1985[2]	1990	1995	2000
Total[3]	2834	3623	2872	2850	3074	3357	3692
Base	950	2045	2135	2850	3074	3357	3692
Direct	263	594	594				
Construction	621	984	143				

[1] Estimates based on the assumption that school age children constitute 30% of the county base population. Estimates for construction and directly employed personnel are based on 1.125 school age children per married worker.

[2] For the years 1985-2000, children from the direct category are added to those of the base category.

[3] Projections of school needs located in Table 8-29 are drawn from these statistics.

The use of trailer facilities and mobile homes is currently alleviating shortages in permanent housing units and can be expected to be a significant factor in the future. However, while mobile homes and trailers are alleviating a problem in terms of housing quantity, the quality of the temporary facilities is often less than adequate. At the present time, the distinction between the "permanent" side of Colstrip and the "temporary" trailer park for construction personnel is obvious. The latter area is considered an "aluminum ghetto" by many residents, overcrowded, and deficient in recreational areas and road maintenance.

The basic attitude of Western Energy officials is that Colstrip will catch up to its needs soon. However, to date, uncertainty over the future has prevented significant additions to residential housing except for that built at Colstrip by Western Energy.

3. Other Social Services

Additional examination of the tables indicates a current and probable shortage of physicians and dentists. Historically, eastern Montana has suffered from deficient medical services, and this trend may be expected to continue in the future. Ambulance service is also in need of improvement, as is fire protection. These services can be upgraded primarily by the purchase of additional equipment. Sanitation systems need additional space for sewage lagoons. The water supply systems of Colstrip and Forsyth are currently being upgraded and will be able to handle additional population influx into the 1980's. Additional manpower is needed by law-enforcement agencies, particularly in Colstrip.

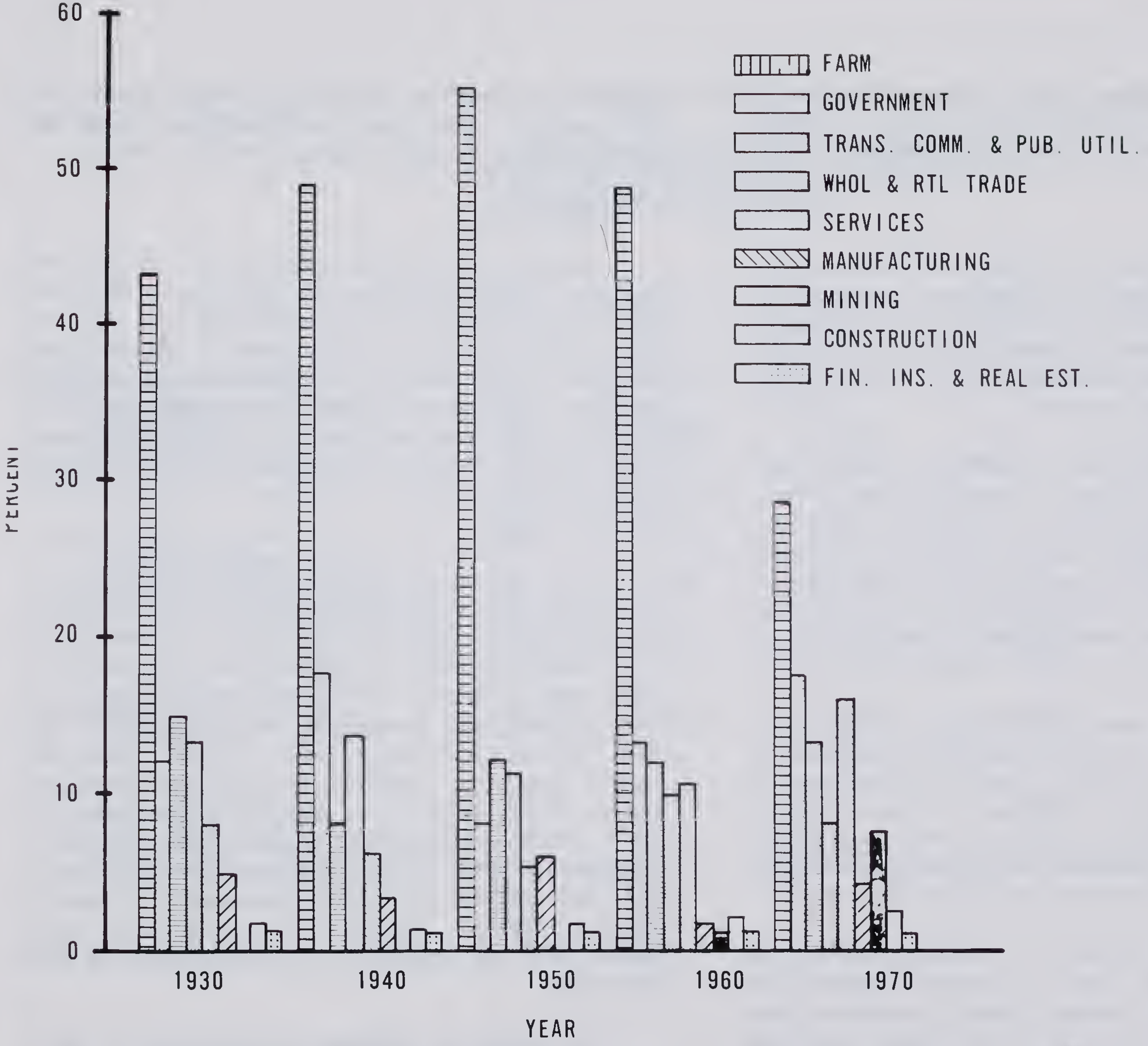
The existing construction boom in Rosebud County has already severely taxed existing social service delivery systems. The impact is being felt most heavily in the schools and in housing, where the population influx has taxed these facilities to capacity. Unless a major effort is made to alleviate these strains, the construction of Units 3 and 4 will work an extra hardship on the county. Other previously mentioned social services are feeling the impact of Units 1 and 2, but to a lesser degree. Construction of Units 3 and 4 will only exacerbate existing impacts on all social services.

8.2.2.4. The Rosebud County Economy

A. Inventory

Historically, the Rosebud County economy has been dominated by agriculture. Agricultural earnings have made up close to 50% of total county earnings over much of the past 40 years.

The relative share of Rosebud County earnings for each of the major economic sectors is shown in Figure 8-8. The absolute amount of



Rosebud County Earnings by Broad Industrial Sector; 1930–1970
(Percent of Total)

FIGURE 8-8

agricultural earnings has increased, but not as rapidly as other sectors of the economy, particularly mining, services and government./8

1. Income

Dollar amounts are shown in Table 8-31 for both personal income and earnings. Personal income includes all non-corporate income (wages, salaries, partnership income, interest, transfer payments), whereas earnings exclude transfer payments and property income.

Table 8-32 indicates that from 1929 to 1970 Rosebud County personal incomes grew from $3,194,000 to $19,094,000, or 497.8% in 41 years. In the same 41-year period. Montana's personal income grew by 672.6%, and the nationwide personal income grew by 836.5%. Thus, total personal income has grown more slowly in Rosebud County than in Montana or the United States as a whole.

Figure 8-9 shows that Rosebud County population has been slowly declining from 8,002 in 1920 to 6,032 in 1970, a 24.6% decline over 50 years. Combining the income increase with the population decrease indicates that per capita personal income increased from approximately $431 in 1929 to $3,165 in 1970 and $3,780 in 1972.

Per capita income is a better measure of individual welfare than is personal income, and in this respect Rosebud County compares very favorably with the rest of the state. Over the 41-year time span (1929-1970), the percentage of increase in Rosebud County per capita income was 23% greater than the corresponding percentage increase in per capita income for the state.

2. Employment

Rosebud County employment by source for 1967 through 1972 is detailed in Table 8-33. The rise in mining activity in Rosebud County over the last six years is demonstrated. Although the absolute magnitudes are relatively small, mining earnings increased by 990% between 1967 and 1972 (Table 8-31), and employment in mining increased 790% (Table 8-33). The influence of mining in Rosebud County will continue to grow over the next 20 years.

The population decline experienced in Rosebud County was a phenomenon common to rural areas throughout the nation in the 1920 to 1970 period. The major industry of these areas, agriculture, has been subject to relatively low prices over the period. The demand for industrial labor has been strong and unit labor prices high. The result was the bidding away of labor from the farm. There have also been large increases in farm labor productivity caused by more capital-intensive, less labor-intensive farm machinery. The net effect of these phenomena has been to make a typical farmer or rancher a large landowner and an efficient, capital-intensive food producer.

The share of earnings attributable to agriculture dropped sharply in the mid-1960's, but by

TABLE 8-31

Personal Income by Major Sources and Earnings by Broad Industrial Sector (In Thousands of Dollars)

	1929	1940	1950	1959	1962	1965
Total Personal Income	3,194	3,325	9,795	12,434	14,241	12,483
Total Wage and Salary Disbursements	1,784	1,531	3,704	NA	NA	NA
Other Labor Income	22	21	80	NA	NA	NA
Proprietors Income	1,060	1,474	4,914	NA	NA	NA
Farm Proprietors Income	668	1,123	4,083	5,434	6,015	1,428
Non-Farm Proprietors Income	392	351	831	930	983	1,052
Property Income	263	185	587	1,152	1,328	1,856
Transfer Payments	75	138	651	951	1,055	1,296
Less Personal Contributions for Social Security Insurance	10	24	141	241	300	374

NA = Not Available

TABLE 8-31 (Cont.)

Personal Income by Major Sources and Earnings by Broad Industrial Sector (In Thousands of Dollars)

	1966	1967	1968	1969	1970	1971	1972
Total Personal Income	12,353	13,527	15,456	17,390	19,094	21,067	24,191
Total Wage and Salary Disbursements	NA	NA	8,286	9,239	9,764	11,044	12,332
Other Labor Income	NA	NA	438	525	605	690	816
Proprietors Income	NA	NA	3,231	3,800	4,467	4,836	6,261
Farm Proprietors Income	1,493	NA	2,107	2,641	3,260	3,721	5,121
Nonfarm Proprietors Income	1,085	NA	1,124	1,159	1,207	1,115	1,143
Property Income	1,874	NA	2,233	2,515	2,714	2,876	3,045
Transfer Payments	1,429	NA	1,783	1,911	2,181	2,395	2,478
Less Personal Contributions for Social Security Insurance	417	NA	515	600	637	774	744

NA = Not Available

TABLE 8-31 (Cont.)

Personal Income by Major Sources and Earnings by Broad Industrial Sector
(In Thousands of Dollars)

	1929	1940	1950	1959	1962	1965
Total Earnings	2,866	3,026	8,698	10,572	12,158	9,705
Farm Earnings	1,214	1,495	4,782	5,290	5,806	1,193
Government Earnings	344	537	676	1,340	1,795	2,157
Manufacturing	(D)	(D)	(D)	145	75	587
Mining	(D)	(D)	(D)	93	159	1,030
Contract Construction	45	40	168	224	200	434
Transportation, Communication and Public Utilities	461	248	1,060	1,172	1,613	1,425
Wholesale and Retail Trade	384	407	975	1,052	1,107	1,188
Finance, Insurance and Real Estate	34	24	81	122	123	147
Services	237	182	447	1,134	1,280	1,544

(D) Data Withheld to Avoid Disclosure

TABLE 8-31 (Cont.)

Personal Income by Major Sources and Earnings by Broad Industrial Sector (In Thousands of Dollars)

	1966	1967	1968	1969	1970	1971	1972
Total Earnings	9,467	10,326	11,955	13,564	14,836	16,570	19,412
Farm Earnings	1,387	2,081	3,093	3,859	4,469	5,018	6,532
Government Earnings	2,161	2,251	2,424	2,459	2,594	2,993	3,302
Manufacturing	698	723	758	983	1,116	1,297	1,349
Mining	261	126	148	432	628	893	1,248
Contract Construction	239	281	358	498	325	205	393
Transportation, Communication and Public Utilities	1,532	1,600	1,721	1,839	1,961	2,082	2,204
Wholesale and Retail Trade	1,225	1,286	1,320	1,166	1,233	1,371	1,471
Finance, Insurance and Real Estate	156	156	158	156	148	196	258
Services	1,808	1,822	1,975	2,172	2,362	2,515	2,655

Source: Bureau of Economic Analysis, U.S. Department of Commerce, and Research Information Systems Division, Montana Department of Intergovernmental Relations.

TABLE 8-32

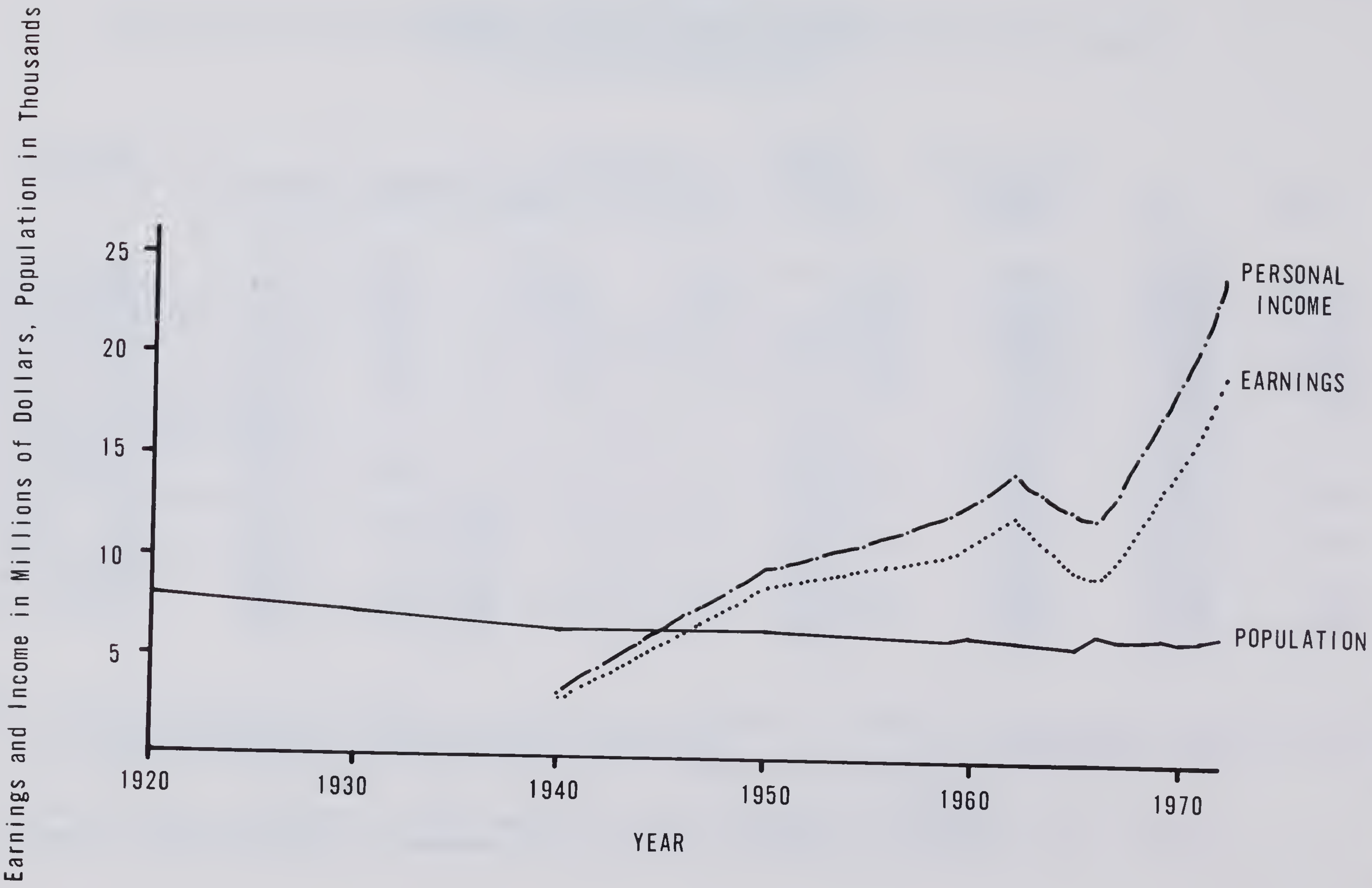
Rosebud County Total Earnings, Personal Income, Employment, Population and Growth Rates, 1920 to 1972

	Earnings (1) (000$)	Personal Income (000$)	Percentage of Change	Employment	Population	Percentage of Change
1920					8002	
1299	2866	3194				
1930					7347	- 8.2
1940	3026	3325	+ 4.1		6477	-11.8
1950	8698	9795	+195.6		6570	+ 1.4
1959	10572	12434	+ 26.9		6100	- 7.2
1960					6187	+ 1.4
1962	12158	14241	+ 14.5		6100	- 1.4
1965	9705	12483	- 12.3		6900	- 3.3
1966	9467	12353	- 1.1		6200	+ 5.1
1967	10326	13527	+ 9.5	2569	6100	- 1.6
1968	11955	15456	+ 14.2	2544	6100	N.C.
1969	13564	17390	+ 12.5	2506	6100	N.C.
1970	14836	19094	+ 9.8	2550	6032	- 1.1
1971	16570	21069	+ 10.3	2782	6100	+ 1.1
1972	19412	24191	+ 14.8	2909	6400	+ 4.9

N.C. No Change

(1), (2) 1929 through 1972 figure is current dollars; no adjustment to reflect price changes.

Source: U.S. Department of Commerce, Bureau of Census; Bureau of Economic Analysis Research and Information Systems Division, Montana Department of Intergovernmental Relations.



Rosebud County Earnings, Personal Income and Population 1920-1972

FIGURE 8-9

TABLE 8-33

Rosebud County Employment by Broad Industrial Sector, 1967 - 1972
(Full and Part Time Wage and Salary Employment Plus Proprietors)

	1967	1968	1969	1970	1971	1972
Total	2,569	2,544	2,506	2,550	2,782	2,909
Total Proprietor	664	663	730	732	737	734
Total Farm Proprietor	431	430	428	423	417	410
Total Non-Farm Proprietor	233	233	302	309	320	324
Wages and Salary Employment	1,905	1,881	1,776	1,818	2,045	2,175
Total Farm Employment	310	267	263	263	286	286
Total Non-Farm Employment	1,595	1,614	1,513	1,555	1,759	1,889
Government	444	445	431	439	455	470
Total Federal	135	131	117	108	111	119
Federal Civilian	135	130	117	108	111	119
Federal Military	1	1	--	--	--	--
State and Local	309	314	314	331	344	351
Private Non-Farm	1,151	1,169	1,082	1,116	1,304	1,419
Manufacturing	168	154	200	213	229	265
Mining	13	19	37	43	79	103
Contract Construction	38	52	55	29	25	39
Transportation, Communication and Public Utilities	205	207	204	207	208	206
Wholesale and Retail Trade	238	256	214	212	238	263
Finance, Insurance and Real Estate	23	21	19	19	25	36
Services	461	454	343	387	495	501
Other	5	6	10	6	5	6

1970 agriculture was emerging with new economic vigor, even with the relatively low prices of that year. With high 1973 vigor, even with the relatively low prices of that year. By 1972 agricultural earnings were up to 34% of the county total. With high 1973 agriculture prices resulting from food shortages, agriculture in Rosebud County, as elsewhere, was efficient, and its economic influence was reasserted.

B. Impacts

The construction and operation of coal-fired generating units in Colstrip affects, in varying degrees, the people and the economies of Rosebud County, the rest of Montana, and the entire nation. However, the greatest impact will be felt within Rosebud County itself, with the towns of Forsyth and Colstrip being the most affected.

1. Impact Techniques

Recent history in Rosebud county shows an average ratio of population to employment of 2.33:1. This ratio is applied to each new primary job created to yield population figures. Secondary employment is then derived from the resulting population estimates.

The results of such an approach reflect the implicit assumptions that all jobs are filled by people from outside the county and that each worker moving into the county brings 1.33 dependents with him or her. Since some jobs would probably be filled by present county residents, the results must be considered maximum population projections and maximum secondary job creation. This does not raise a problem for comparisons made within these sections, since, for the alternatives considered, projections are consistent with each other. However, these projections are not consistent with those made in Section 8.2.2.1.

In preparing the projections for Rosebud County, emphasis was placed on analysis of the individual firm within major industries. The projection of employment used in mining, manufacturing, and transportation, communication, and public utility industries anticipated changes in physical output, changes in productive capacity, and changes in output per man. By utilizing any of these three, a degree of dynamics was introduced into the projection process. For example, the amounts of coal shipped from Westmoreland Coal, Western Energy, and Peabody Coal help determine the number of people employed by Burlington Northern in Forsyth, Montana.

a. Coal Mining

In the Rosebud County coal mining industry, individual company estimates of output per man were used in obtaining employment from projected coal tonnages to 1981. Once yearly employment projections were derived at the firm level, 1973 earnings based on total labor costs at the firm level were applied to arrive at total earnings per firm, and the firms within the industry summed to an industry level. In those few situations where proprietary earnings were present, 1973 proprietary earnings or a five-year average was used in the total earnings projections.

b. Agriculture

In agriculture, the Rosebud County earnings projections were based on physical quantities of production of particular agriculture commodities times the average 1973 prices of those commodities. In the livestock section, physical projections were based on Rosebud County's relative efficiency compared to state production for each commodity. In the crops section, acreage and yields per acre by commodity were used in the projection of physical quantities per commodity. The assumption was made that increasing acreage in Rosebud County would continue to be devoted to livestock input items (corn silage, hays, and feed grains).

c. Construction

In the construction industry, projections were based on actual or anticipated capital expansion plans of individual firms or government entities. Construction employment projections for the Colstrip generation units and Western Energy's coal mining activities were based on engineering analysis, and they were time-sequenced based on construction timetables.

d. Residence Adjustment

The Colstrip data were adjusted for out-of-county commuting using two commuting employment estimates obtained from Western Energy Company. The out-of-Rosebud-County employment commuting estimate was 10.4% in the winter and 25.1% in the summer of the total employment on the Colstrip project. Employment included Bechtel and the subcontractors. Those estimates were averaged, and they were used to residence - adjust all Rosebud County construction employment.

e. The Threshold Model

In the service industries, employment was estimated for each year based on population changes that occurred as a result of employment changes in the sectors of mining, manufacturing, agriculture, construction, transportation, communication, and public utilities. The technique used to estimate these changes is called a threshold model. The model projects the amount of service sector employment that will occur as a result of changes in the county population level induced by changes in employment in the primary sectors.

For each service industry there is a different threshold which determines the employment changes that will occur in that sector. For example, 200 new people in a community may generate enough sales of food to cause one new person to be employed in food retailing. However, it may take 20,000 people before enough brokerage sales are generated for a new employee to be added to a stock brokerage business.

The threshold model used here incorporates 35 separate regression equations into the calculation of four division level service sectors: (1) Wholesale-Retail Trade, (2) Finance, Insurance and Real Estate; (3) Services, and (4) Government. The relationship between population and employment estimated by the regression equations is based on county data for the entire state of Montana.

Two sources of bias are introduced by using existing county data. They are both imbedded in the fact that Rosebud County, with the present and the proposed construction activity, may be an atypical county with respect to the relationships being measured.

The first bias is that the jobs in Rosebud County which will be causing the initial population changes are construction and mining jobs, and wages for both are higher than average Montana wages. The second bias, and probably much more important, is that the data used to estimate the population-service employment relationships come from a group of more or less stable counties whose rate of population change has been slow--essentially equilibrium conditions. Rosebud County certainly will not conform to those conditions over the next six years. As a result, the service industries may be reluctant to make additional investments and hire additional people. If so, the following estimates of population and employment will be high. Therefore, the resulting projections should be interpreted as being upper bound estimates.

2. Projections of Employment and Earnings in Rosebud County

Three alternative sets of assumptions were made, as follows:

Scenario	Generating Units Constructed	Coal Production (all cases include existing contracts).
I (Minimum Growth)	1,2	Coal for 1,2
II (Coal Export)	1,2	Coal for 1,2,3,4
III (Maximum Growth)	1,2,3,4	Coal for 1,2,3,4

The difference between Scenario II and Scenario III is one of where the coal is utilized. In II, it is mined and shipped out of Rosebud County; in III, Units 3 and 4 are constructed at Colstrip, and the coal is burned there. All scenarios include present sales contracts as a part of coal production.

Employment projections for the years 1973 through 1981 for each scenario are presented in Table 8-34. In each scenario, the first six employment categories were established by interviews or independent estimates. The TCPU classification consists of transportation, communications and public utility employment. The last employment category (Service Sector Employment) was determined by the threshold model estimates and is a function of the previous year's population. This employment category includes the wholesale and retail trades, finance, insurance and real estate, government employees, and nonfarm proprietors.

a. Minimum Growth - Scenario I

From 1972 to 1974, without any economic activity related to Units 3 and 4, Rosebud County personal income will grow by 119% (See Table 8-35). In the same two years county population will expand by almost 60%, from 6,400 people in 1972 to 10,744 people in 1974.

b. Coal Export - Scenario II

If Units 3 and 4 are not constructed but coal related to them is mined, personal income will be $50,322,000 in 1981, some 15% higher than total real personal income at the end of construction of Units 1 and 2. The county population under the same scenario would be 11,084 people by 1981, 8.7% higher than at the end of construction of Units 1 and 2.

c. With Units 3 and 4 - Scenario III

If Units 3 and 4 are constructed, between 1974 and 1977 the county must assimilate another $26,654,000 in real personal income and an additional 5,408 people. This is in addition to the 119% increase in real personal income and the 60% increase in people from Units 1 and 2. By 1977, Rosebud County would have a population about 2½ times its 1972 population, and total personal income would be approximately 3¼ times the 1972 level.

d. Comparison of the Three Scenarios

In Figure 8-10, population and employment projections are displayed through time. Population and employment will essentially level off unless Units 3 and 4 are built. If Units 3 and 4 are constructed, Rosebud County's population would grow to 16,152 in 1977, or 6,023 more than without Units 3 and 4.

On a long-term basis the effects of Units 3 and 4 on both population and employment (see "Beyond 1981" in Table 8-35 and Figure 8-10) are not very large. Whereas the coal mining associated with export of coal in Scenario II would add 477 permanent jobs, the manning of Units 3 and 4 would add only 282 more direct and secondary jobs.

TABLE 8-34

Residence Adjusted Employment Estimated For Alternative Scenarios, Rosebud County, 1973 to 1981

	1973	1974	1975	1976	1977
Scenario I:					
Ag. Proprietors	406	402	398	396	394
Mining Employees	217	199	289	469	540
TCPU Employees	159	227	273	300	302
Ag. & Ag. Serv. Employees	300	308	316	325	333
Manfg. Employees	131	150	161	167	171
Construction Employees	1759	2334	2560	2584	2558
Total County Employment	3333	4611	4604	4437	4347
Scenario II:					
Ag. Proprietors	406	402	398	396	394
Mining Employees	217	199	289	469	540
TCPU Employees	159	227	273	300	302
Ag. & Ag. Serv. Employees	300	308	316	325	333
Manfg. Employees	131	150	161	167	171
Construction Employees	361	991	607	196	49
Serv. Sector Employment	1759	2334	2560	2584	2558
Total County Employment	3333	4611	4604	4437	4347
Scenario III:					
Ag. Proprietors	406	402	398	396	394
Mining Employees	217	199	289	469	540
TCPU Employees	159	227	273	320	382
Ag. & Ag. Serv. Employees	300	308	316	325	333
Manfg. Employees	131	150	161	167	171
Construction Employees	361	991	912	1105	1225
Serv. Sector	1759	2334	2763	3332	3887
Total County Employment	3333	4611	5112	6114	6932

TABLE 8-34 (Cont.)

Residence Adjusted Employment Estimates For Alternative Scenarios, Rosebud County, 1973 to 1981

	1978	1979	1980	1981
Scenario I:				
Ag. Proprietors	393	392	391	390
Mining Employees	543	580	552	552
TCPU Employees	314	322	323	323
Ag. & Ag. Serv. Employment	335	337	339	341
Manfg. Employees	173	173	166	161
Construction Employees	67	65	41	41
Serv. Sector Employment	2563	2595	2580	2568
Total County Employment	4388	4464	4392	4376
Scenario II:				
Ag. Proprietors	393	392	391	390
Mining Employees	583	701	713	713
TCPU Employees	314	322	323	323
Ag. & Ag. Serv. Employment	335	337	339	341
Manfg. Employees	173	173	166	161
Construction Employees	67	65	41	41
Serv. Sector Employment	2590	2695	2752	2788
Total County Employment	4455	4685	4725	4757
Scenario III:				
Ag. Proprietors	393	392	391	390
Mining Employees	583	701	713	713
TCPU Employees	408	417	418	418
Ag. & Ag. Serv. Employment	335	337	339	341
Manfg. Employees	173	173	166	161
Construction Employees	667	208	41	41
Serv. Sector Employment	3930	3739	3509	3353
Total County Employment	6489	5967	5577	5417

TABLE 8-35

Earnings, Personal Income, Employment, and Population 1972 to 1981, and Employment and Population Differences Beyond 1981, Rosebud County, Alternative Scenarios

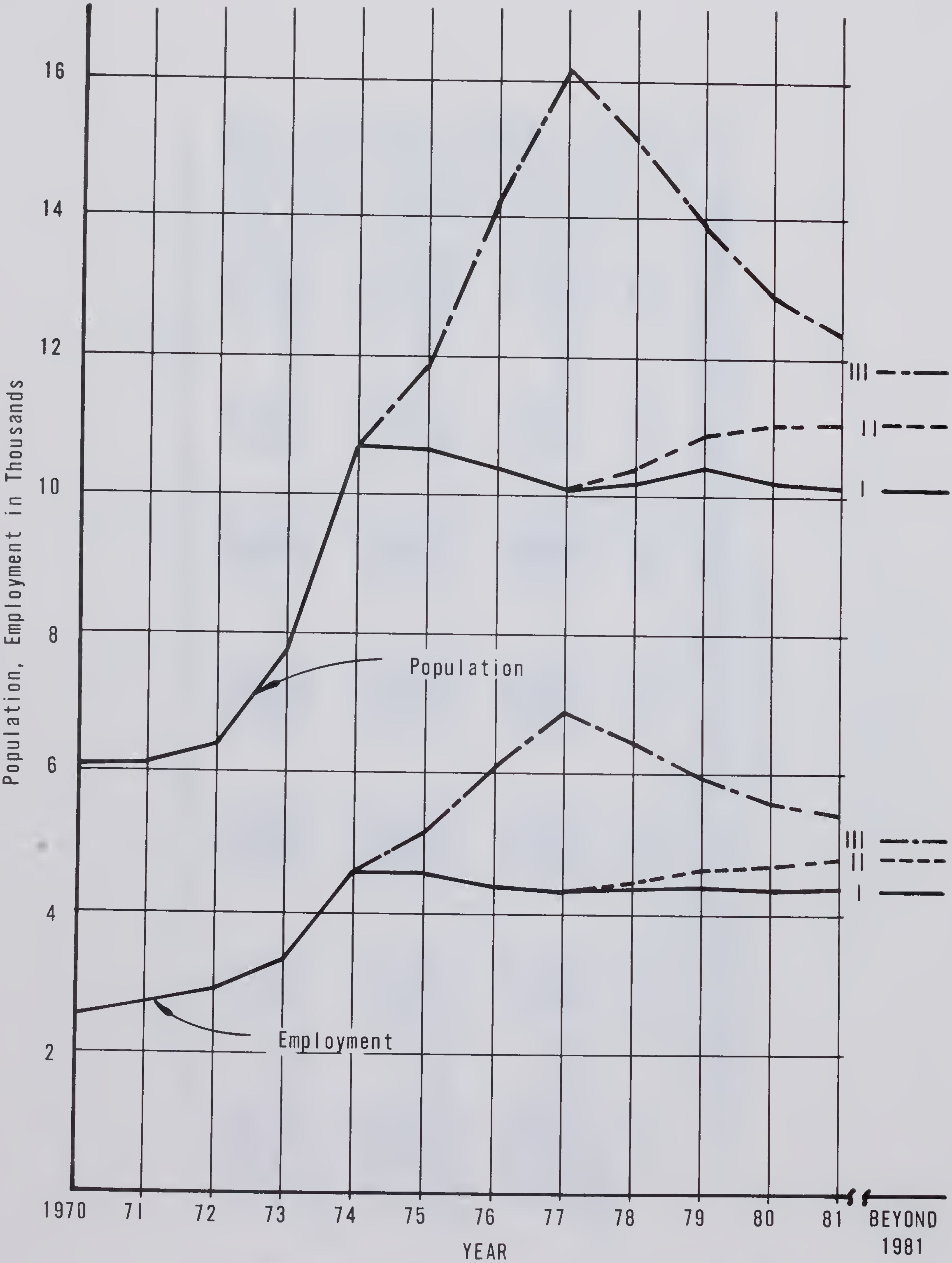
	1972	1973	1974	1975	1976
Scenario I:					
Earnings (000$)	19,412	28,298	43,133	40,835	37,164
Personal Income (000$)	24,191	34,762	52,984	50,161	45,633
Employment	2,909	3,333	4,611	4,604	4,437
Population	6,400	7,766	10,744	10,727	10,338
Scenario II:					
Earnings (000$)	19,412	28,298	43,133	40,835	37,164
Personal Income (000$)	24,191	34,762	52,984	50,161	45,633
Employment	2,909	3,333	4,611	4,604	4,437
Population	6,400	7,766	10,744	10,727	10,338
Scenario III:					
Earnings (000$)	19,412	28,298	43,133	47,374	57,633
Personal Income (000$)	24,191	34,762	52,984	58,194	70,797
Employment	2,909	3,333	4,611	5,112	6,114
Population	6,400	7,766	10,744	11,911	14,246

TABLE 8-35 (Cont.)

Earnings, Personal Income, Employment, and Population 1972 to 1981, and Employment and Population Differences Beyond 1981, Rosebud County, Alternative Scenarios

	1977	1978	1979	1980	1981	Beyond* 1981
Scenario I:						
Earnings (000$)	35,517	36,344	37,485	36,663	56,778	
Personal Income (000$)	43,629	44,645	46,046	45,037	45,178	
Employment	4,347	4,388	4,464	4,392	4,376	Base
Population	10,129	10,224	10,401	10,233	10,196	Base
Scenario II:						
Earnings (000$)	35,517	37,225	40,262	40,576	40,966	
Personal Income (000$)	43,629	45,728	49,458	49,844	50,322	
Employment	4,347	4,455	4,685	4,725	4,757	+ 477
Population	10,129	10,380	10,901	11,009	11,084	+1,112
Scenario III:						
Earnings (000$)	64,830	56,458	49,771	45,935	45,251	
Personal Income (000$)	79,638	69,353	61,138	56,426	55,586	
Employment	6,932	6,489	5,967	5,577	5,417	+ 759
Population	16,152	15,119	13,903	12,994	12,622	+1,768

*Differences represent population and employment differences between three scenarios



EMPLOYMENT AND POPULATION 1970-1981 AND BEYOND 1981
ROSEBUD COUNTY, SCENARIOS I, II AND III

FIC E 8-

Construction of Units 3 and 4 would create very great population stress and a correspondingly large number of jobs, but the large employment impact would occur only during construction. The permanent employment impact of Units 3 and 4 on the Rosebud economy would be much smaller than the impact of mining itself. To the extent that coal shipping would add job opportunities in Rosebud County, the effect of Units 3 and 4 (Scenario III) on long-range employment above and beyond Scenario II would be still smaller.

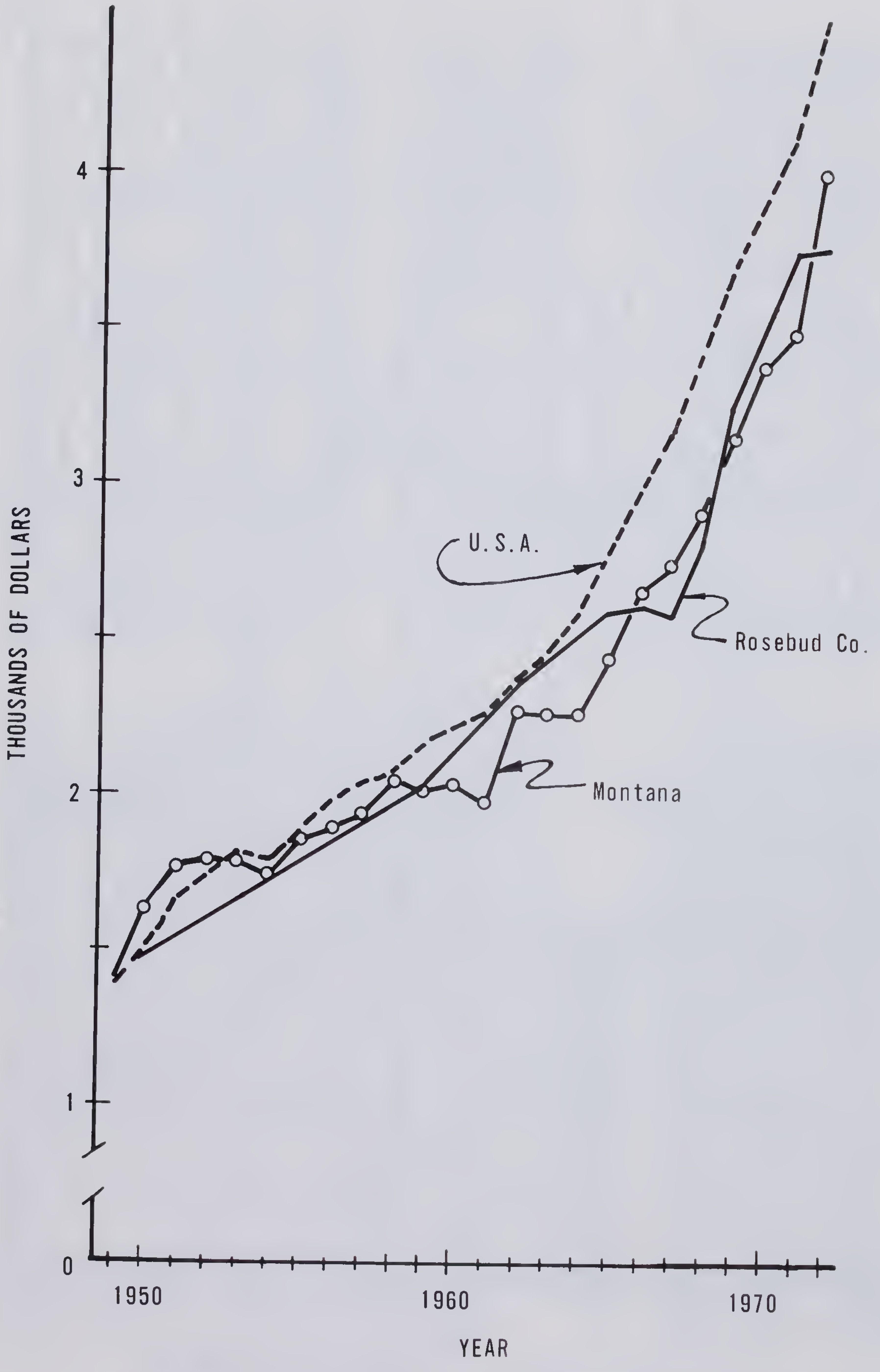
e. Comparison of Rosebud County Projections With Other Regions

Per capita personal income is a basic economic measure of material well-being. When compared with that in other geographic areas, it becomes a measure of relative affluence. In Figure 8-11, the per capita personal income (in current dollars) is charted for the United States, Montana, and Rosebud County from 1949 to 1972. In times past, Montana's per capita income has exceeded the national average, but since 1952 Montana's per capita income has been below the national average. Rosebud County's relative income measure has exceeded the Montana measure on occasion, but has never exceeded the national average. By 1980 real income per individual will exceed the Bureau of Economic Analysis' projected real per capita personal income for Montana, but it will be slightly below the national average (98%). In Figure 8-12, per capita personal income has been charted for the three scenarios using a current dollar base. In all three scenarios, as construction winds down and operational people begin working in the county, and as the county expands its service sectors, personal income per person will decline from the peak construction period incomes. Interestingly, per capita personal income in scenario II, a maximum coal mining scenario, exceeds the real per capita personal income in scenario III with Units 1, 2, 3, and 4. This is due to the relatively high wages paid in the coal mining industry.

3. Local Government Finances

To estimate the public sector impacts, it is necessary to take into account some levels of local government other than the county. For purposes of this analysis these are the incorporated towns (in this case the only one, Forsyth) and the school districts.

In the bookkeeping for county government in Montana, several principal sources of receipts are identified. These include general revenue (taxes) and a number of miscellaneous revenues from collections, fees and licenses, rentals and sales, payments from state and federal sources for specified purposes, and, in recent years, revenue sharing. The largest share of funds handled by the county are the so-called trust and agency, or "T & A" receipts, which simply pass through the county treasury from state, federal, and local sources to the school districts and other special districts.



Per Capita Personal Income; Rosebud County, Montana, and the U.S.A., 1949-1972, in Current Dollars

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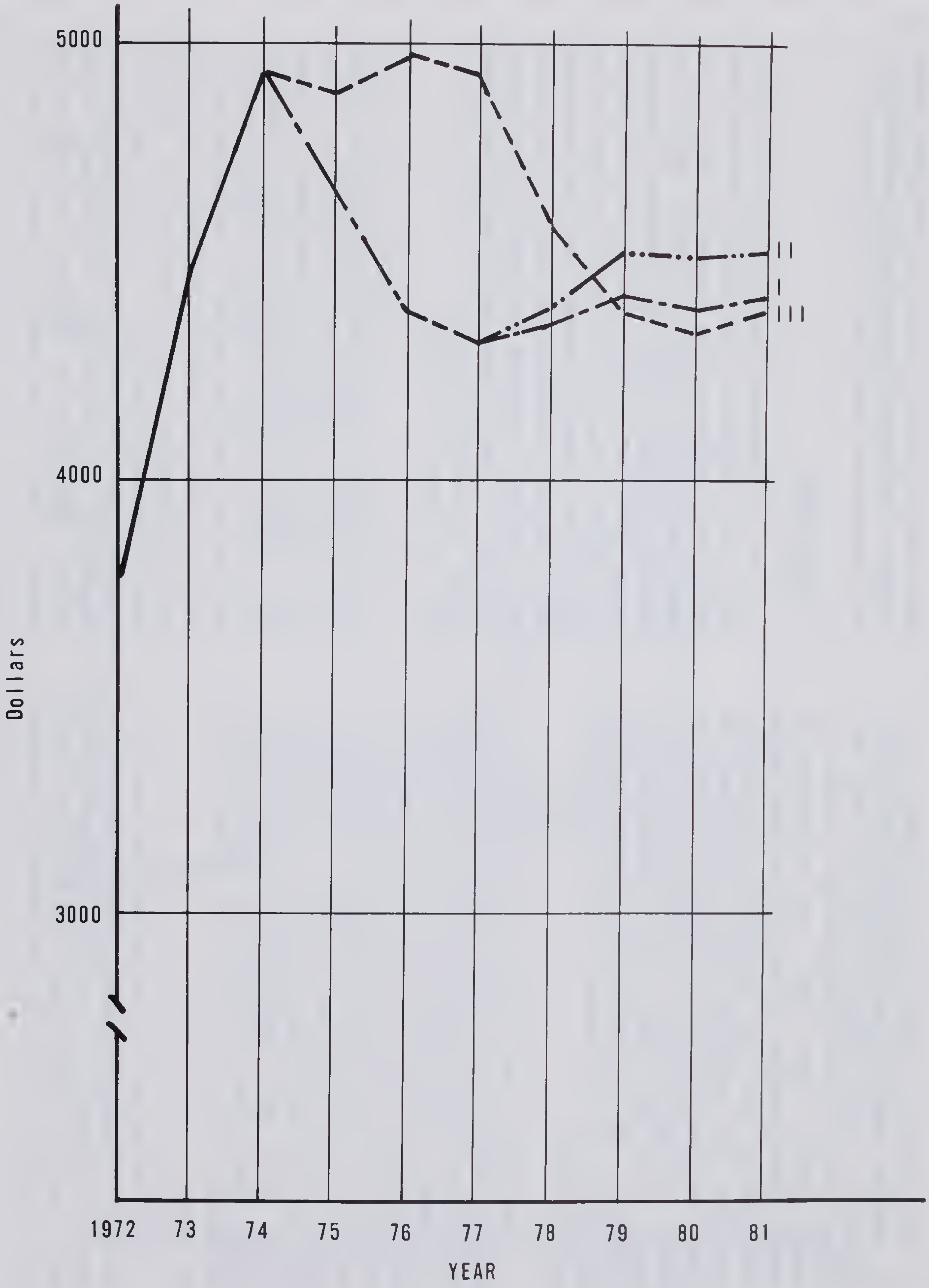


Per Capita Personal Income, Rosebud County
1973–1981 in Current Dollars. Scenarios I, II and III

FIGURE 8-12

The primary source of county income is the ad valorem property tax, levied on varying proportions of the assessed value of real and personal property and on various other values. In Rosebud County since 1967, the proportion of county income provided by property tax has varied from 75% or more to around 40%. Although the proportion has decreased with the increase in other components such as revenue sharing, the amount of the tax has increased, as shown in Figure 8-13. The trend can be explained by a combination of increasing costs, rising taxable valuations, and the general expansion of government services.

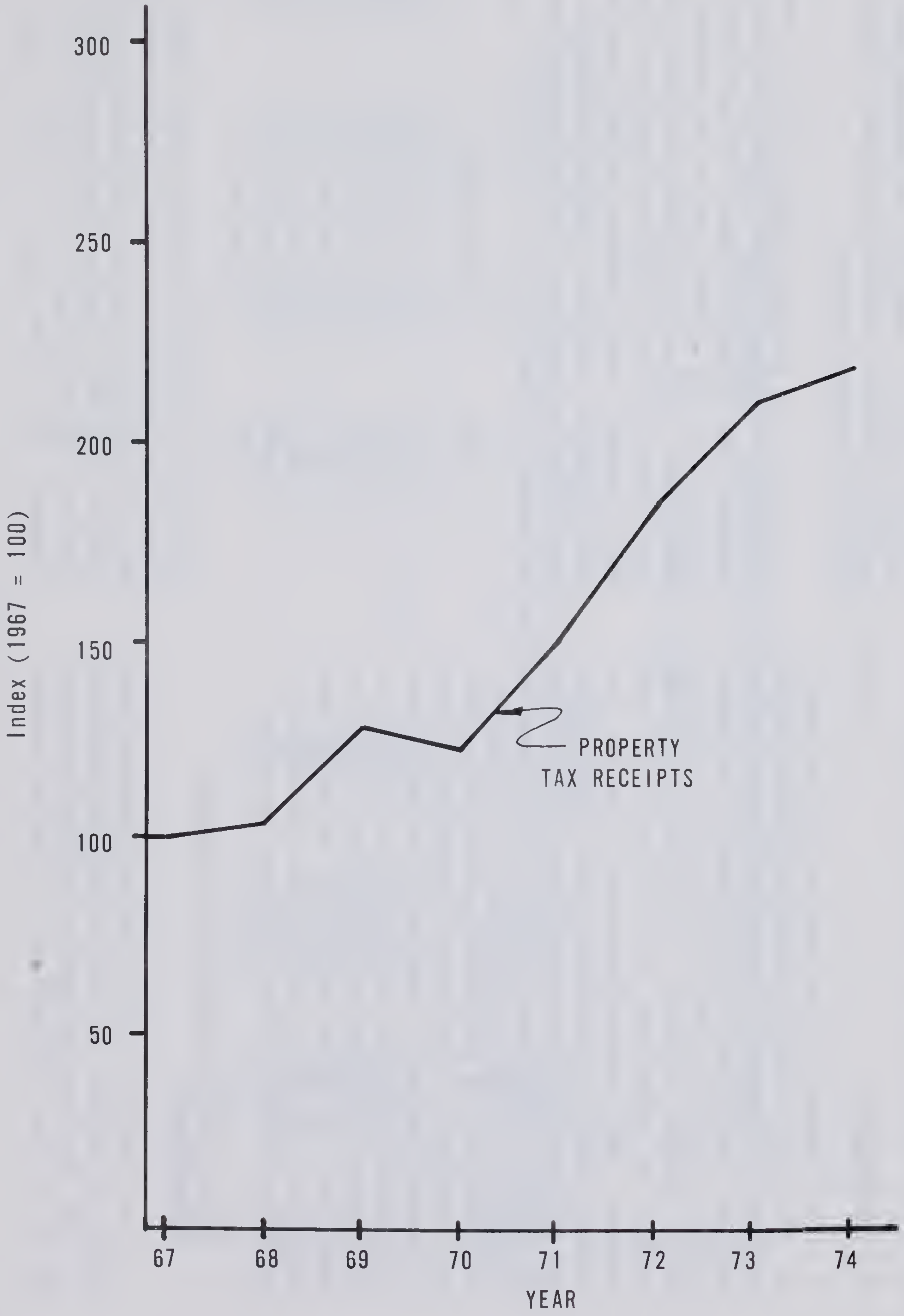
Since 1967, that part of the millage rate in Rosebud County for general government purposes has remained nearly constant, but, because of the requirements for education costs, the total rate has increased from 75.4 mills in fiscal year 1966-1967 to 114.2 mills in 1973-74, according to reports of the Montana Taxpayers' Association. Total taxable valuation of real and personal property in the county decreased in the 1960's before 1967, but between that year and 1973, partly under the influence of increased coal development, it rose at an average rate of 6½% per year.

The actual rate is determined each year by a process of budget estimation for each fund (or general category of use) for the next fiscal year. From the total estimated requirements there are subtracted the expected sources of revenue other than ad valorem taxes. The remaining amount is then divided by the applicable taxable property valuation to determine the millage rate.

a. Coal Taxes

For an operation like the Colstrip complex, there are five coal-based taxes in Montana that apply, and another on the production and sale of electrical power. Three of these taxes, the Corporate License Tax, the Resource Indemnity Trust Fund Tax, and the Electric Energy Production License Tax, are paid to the state and do not affect county finances. Of the remaining three, which contribute directly to the county, two contribute through the county to the school district in which the coal is mined. Both coal mines in Rosebud County are in school district #19, the Colstrip district.

Besides real and personal property taxes, paid at rates which combine the millage of the county and the district and are applied to 40% of the assessed valuation, the operators of a strip coal mine are also taxed on the net proceeds of the mine. The same combined millage rate is applied to the gross value of coal mined during the year, less the costs of production (including land reclamation costs), but taxed at the full assessed value. In addition, the 1974 legislature provided that 3 cents per ton of coal mined, regardless of its value, is returned by the Montana Department of Revenue each year to the general fund of the county in which the coal is



Indexes of Rosebud County
Property Tax Receipts, 1967–1974

FIGURE 8-13

mined. In Rosebud County this 3 cents comes out of a total of 34 cents per ton which the state collects on coal with the heat value (BTU per pound) of the subbituminous coal mined there.

b. Projections

The effects of the proposed Colstrip plants on the tax burden of county residents were not estimated district by district, because public services are a function of population, and population statistics are not reported by school or other special district. Consequently, it was decided to make use of a combination of three sources, the Montana Department of Revenue, the annual reports of the County Clerk and Recorder, and the Forsyth city records. Using a combination of school levies and special levies, reported biennially by the Montana Department of Revenue, and measures of the local-tax-supported portion of county and city government expenditures gives a measure for which there are historical records for comparison, and which can be projected into the future. Population projections have been based on the three scenarios, and assumptions were made as to future costs of governmental services supplied by the county and its units.

i. Local-Tax-Supported County Government Expenditures

Per capita costs of county government have shown an increase in recent years, although some of the apparent increase can probably be attributed to the difficulties in making accurate population estimates. The Census Bureau, for example, reported Rosebud County's population to be constant from 1967 to 1971. During this period actual counts of student population were increasing fairly steadily, and expenditures for county government rose from one-half million to nearly one million dollars.

If it is assumed, however, that the range, magnitude, and per capita costs of services provided by county government through 1981 will be about the same as they were on the average for the years 1973 and 1974, then this basis can be used to project county budget through 1981. Using this method, county budgets for the years 1974-1975 through 1980-1981, based on scenario III population projections, would be as follows to the nearest $500:

Year	County Budget
1975	$2,779,500
1976	3,324,500
1977	3,769,000
1978	3,528,000
1979	3,244,500
1980	3,032,000
1981	2,945,500

Since 1967, 60.6% of the total county budget was raised by property taxation. It is assumed that this percentage will be representative in the future. The above figures are thus multiplied by .606 to derive column 2 in Table 8-36 for Scenario III. Since these figures have been

TABLE 8-36

Estimated Rosebud County Tax-Supported Governmental Costs (1973 Dollars) Projected To 1981 With Taxable Valuation, Composite Millage Rates.

Scenario I Projections

Year	Local Tax-Supported County Gov't. Expenditures ($000's)	School District Costs ($000's)	Forsyth City Tax Costs (000's)	Bond Retirement Cost	Coal Mines License Tax Receipts ($000's)	Total Expenditures ($000's)	Taxable Valuation ($000's)	Required Millage Rates
1974	1520	2176	115.0		153	3658.00	25692	142.4
1975	1518	2173	114.8	53350	255	3604.15	36775	98.0
1976	1463	2094	110.6	"	459	3261.95	46803	69.7
1977	1433	2052	108.4	"	543	3103.75	56835	54.6
1978	1446	2071	109.4	"	543	3136.75	60475	51.9
1979	1472	2107	111.3	"	573	3170.65	60020	52.8
1980	1448	2073	109.5	"	543	3140.85	59998	52.3
1981	1443	2065	109.1	"	543	3127.45	59842	52.3

TABLE 8-36 (Cont.)

Estimated Rosebud County Tax-Supported Governmental Costs (1973 Dollars) Projected To 1981 With Taxable Valuation, Composite Millage Rates.

Scenario II Projections

Year	Local Tax-Supported County Gov't. Expenditures ($000's)	School District Costs ($000's)	Forsyth City Tax Costs ($000's)	Bond Retirement Cost	Coal Mines License Tax Receipts ($000's)	Total Expenditures ($000's)	Taxable Valuation ($000's)	Required Millage Rates
1974	1520	2176	115.0		153	3658.00	25692	142.4
1975	1518	2173	114.8	53350	255	3604.15	36775	98.0
1976	1463	2094	110.6	"	459	3261.95	46803	69.7
1977	1433	2052	108.4	"	543	3103.75	56835	54.6
1978	1469	2102	111.1	"	585	3150.45	60475	52.1
1979	1544	2211	116.8	"	699	3226.15	61576	52.4
1980	1558	2230	117.8	"	711	3248.15	64665	50.2
1981	1568	2245	118.6	"	711	3273.95	66064	49.6

TABLE 8-36 (Cont.)

Estimated Rosebud County Tax-Supported Governmental Costs (1973 Dollars) Projected To 1981 With Taxable Valuation, Composite Millage Rates.

Scenario III Projections

Year	Local Tax-Supported County Gov't. Expenditures ($000's)	School District Costs ($000's)	Forsyth City Tax Costs ($000's)	Bond Retirement Cost	Coal Mines License Tax Receipts ($000's)	Total Expenditures ($000's)	Taxable Valuation ($000's)	Required Millage Rates
1974	1520	2176	115.0		153	3658	25692	142.36
1975	1685	2413	127.4	53350	225	4024	36775	109.42
1976	2016	2885	152.4	"	459	4640	51003	91.12
1977	2285	3271	172.8	"	543	5240	70035	74.81
1978	2139	3062	161.8	"	585	4831	85875	56.26
1979	1967	2816	148.8	"	699	4287	96829	44.27
1980	1838	2632	139.0	"	711	3952	101911	38.78
1981	1786	2556	135.1	"	711	3819	103910	36.76

estimated on a per capita basis, the corresponding numbers for Scenarios I and II are different only because of differences in projected population base. For all three scenarios the figure of $141.80 per capita is used.

ii. School District Costs

The basis for projection of this public expenditure in the present analysis is tax cost per student, which in Rosebud County averaged $913.25 in the school years 1972 and 1973 -- with considerable variation between schools and school districts. This figure is used in the projections under column 3 of Table 8-36.

Student population estimates have been based on the historical relationship between total population and numbers of enrolled public school students in the county. This basis is likely to give a somewhat overstated student population, because the greatest population "peaks" in the future projections are caused by the presence of construction workers, who include a somewhat higher proportion of single persons than in the customary population of Rosebud County before and after the construction period.

iii. Forsyth City Tax Costs

Most of the funds for this purpose come from fees and charges arising out of the city's operations, but amounts varying from 25% to 36% of the total in recent years have come from taxation. For estimates of future amounts it was assumed, to be safe, that the population of Forsyth would tend to change at a reate corresponding to that of the county. Tax-supported expenditures for Forsyth have averaged $10.70 per capita using county-wide population as the base, so this figure was used to compute the column in Table 8-36 on "Forsyth City Tax Costs."

iv. Bond Retirement Costs

It was assumed that, beginning in 1975, a total of $1,000,000 would have to be raised by a bond issued for capital expenditures -- in this case, 20-year serial bonds at a 6.7% interest rate. This would cover such items as a new school building for Colstrip, a jail at the county seat, purchase or construction of other school facilities there, or other expenditures.

In actual practice, the county does not sell bonds for construction of schools in a particular district. To be completely realistic, careful and detailed estimates would have to be made, taking into account the finances of the district in which school construction would take place and in which bonded indebtedness would be incurred.

School districts are limited, in the bonded indebtedness they may incur, to 5% of the total assessed valuation. In 1974, however, Colstrip Elementary School District, with an assessed valuation of $17 2/3 million, still has a permissible margin of $842,543 it may raise by bond issues; and for the high school district, the permissible amount is $847,085. Similarly, the Forsyth Elementary and high school districts have margins of $556,944 and $773,150, respectively.

v. Coal Mines License Tax

Beginning with 1974, additional funds began coming into the county's General Fund from the Strip Coal Mines License Tax. At 3¢ per ton of coal mined by Western Energy and Peabody Coal Companies, this tax will contribute amounts starting with $225 thousand in 1975 and rising to $711 thousand in 1980 and 1981. These amounts are subtracted from the dollars to be raised by property taxation each year in the projections.

vi. Taxable Valuation

Since 1967, Rosebud County's tax base (measured by total taxable valuation) has approximately doubled, from about $10 million to just under $20 million, with most of the growth taking place since 1970. In the future there would be two sources of increase in the tax base as a result of coal company operations. One would be the increased valuation of the power generation and coal mining complexes and the residential and commercial growth of Colstrip. The other would be the net proceeds, based on value of the coal mine itself, less the cost of producing it. For purposes of this particular discussion, however, only the taxable net proceeds of Western Energy Company are included, so the taxable values are understated each year by the amount of Peabody's net proceeds. Figure 8-14 shows what would happen to taxable valuation in the county if the assumption is made that all other valuation remains constant at the 1974 level.

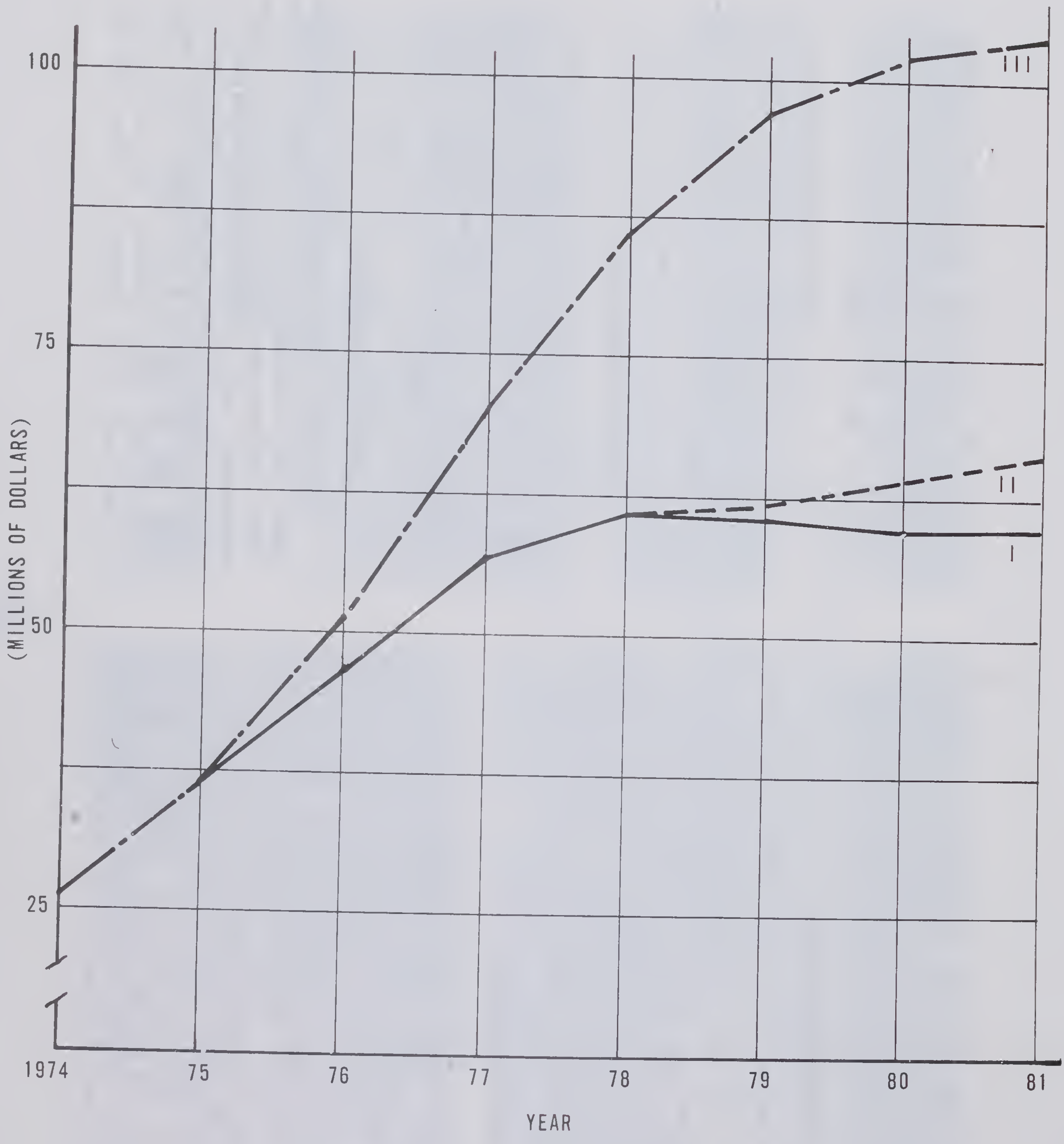
Based on these rather conservative assumptions, and using the total governmental expenditure projections described above, it is then possible to compute a sort of composite millage rate required each year to raise the necessary funds.

vii. Required Millage Rates

Results of the calculations of projected total county government costs supported by local taxation, and composite millage rates based on future increases in taxable valuation, are given in Table 8-36. The required millage rate is calculated by dividing taxable valuation into the total expenditures.

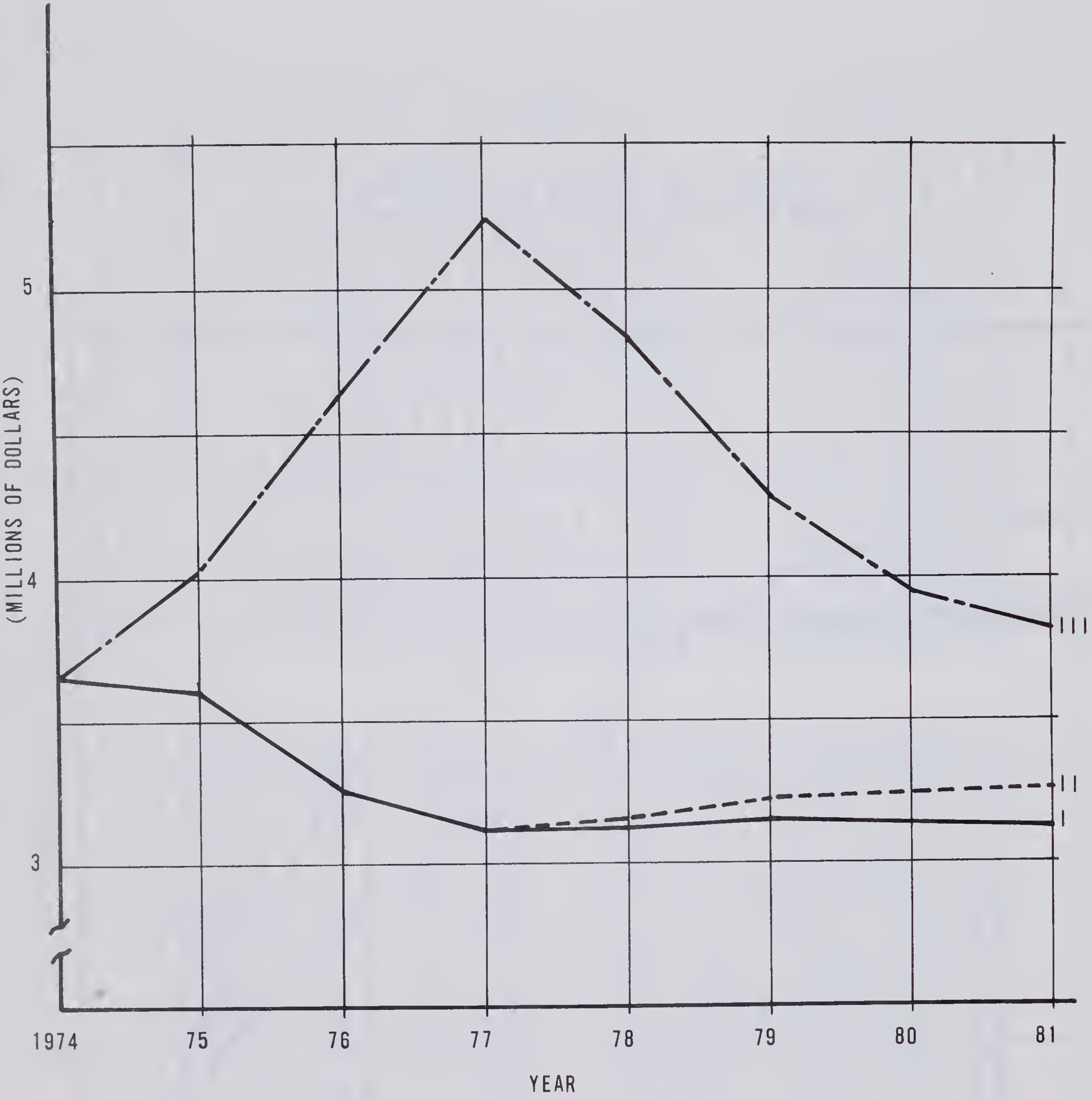
viii. Summary of Projection

Estimated total expenditures and millage rates are shown graphically in Figures 8-15 and 8-16. Because expenditures are linked closely to population, they peak in 1977, the year of maximum population under Scenario III conditions. Under either Scenario I or Scenario II, expenditures peak in 1974.



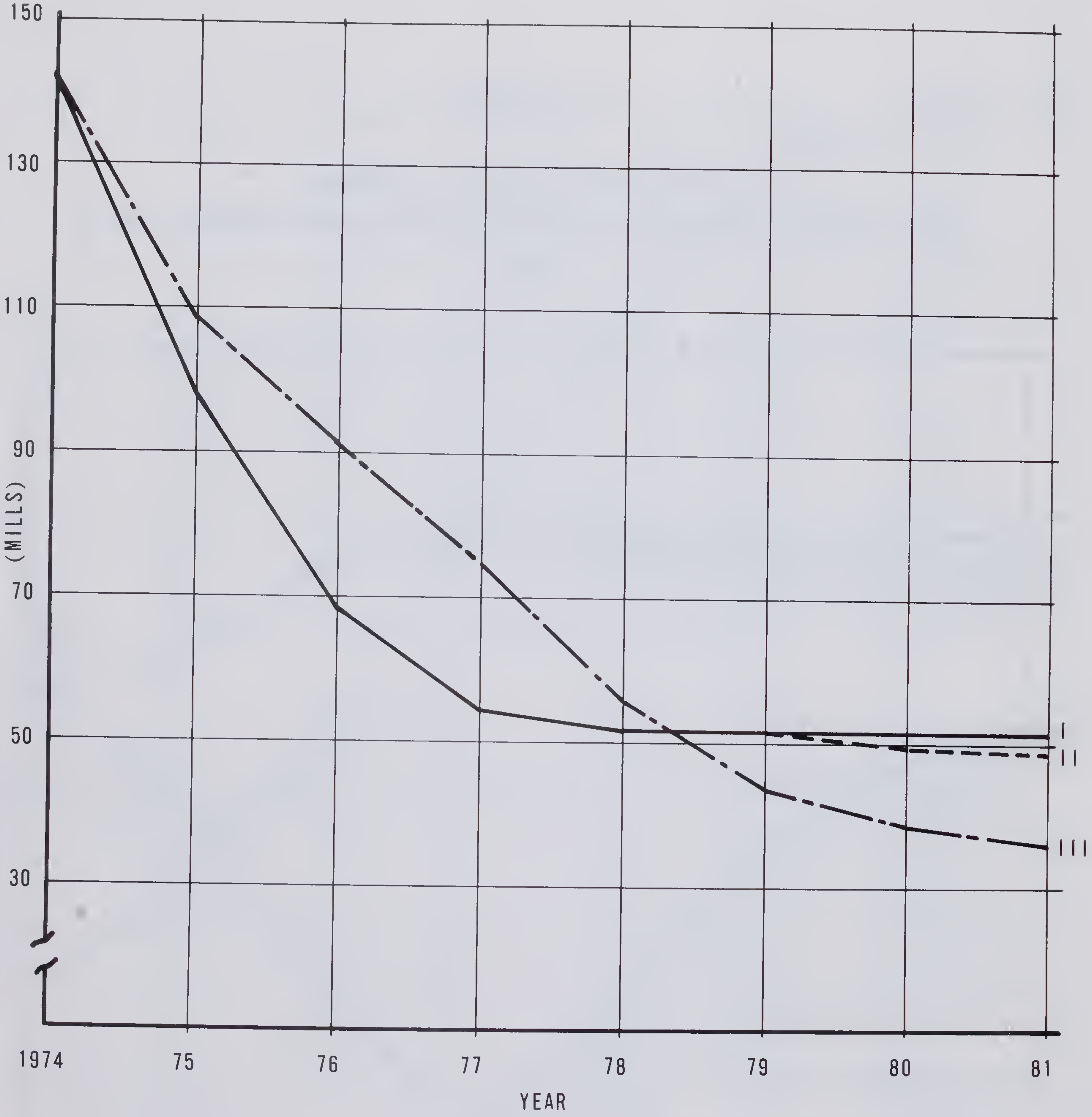
Estimated Rosebud County Taxable Valuation
Scenarios I, II and III, 1974–1981

FIGURE 8-14



ESTIMATED ROSEBUD COUNTY TOTAL EXPENDITURES TO BE COVERED BY PROPERTY TAXES.
SCENARIOS I, II AND III, 1974 to 1981

FIGURE 8-15



ESTIMATED ROSEBUD COUNTY REQUIRED MILLAGE RATES
SCENARIOS I, II AND III, 1974 to 1981

FIGURE 8-16

For all three scenarios, predicted millage rates fall from 1974 forward, but they should fall much more sharply over the next four years under Scenarios I and II than they would under Scenario III. Starting in 1979 Scenario III millage rates fall substantially below required millage rates for the other two scenarios, as Units 3 and 4 would come fully into the county property base.

8.2.2.5. Impacts on State-wide Employment

During October 1974, a survey was conducted of construction manpower available for work at Colstrip if Units 3 and 4 are to be built. The purposes of the survey were to estimate the supply and demand for certain construction trades (e.g., boilermakers, carpenters, electricians, ironworkers, pipefitters, operating engineers, and laborers) and to examine the capability of the Montana labor force to provide the requisite number of craftsmen. Information was primarily gathered by personal and telephone contacts with union representatives throughout the state. Supplementary information was provided by the Montana Department of Labor and Industry (Employment Security Division and Labor Standards Division) and Bechtel Corporation.

A. Current Employment Situation

On September 17, 1974, the Billings employment office of the Employment Security Division conducted a survey of employment in the Colstrip area, and at that time 1,483 persons were reported to be working. Plant construction accounted for 1,083 jobs; Western Energy Company's mining operations, 150; and other construction (e.g., housing, commercial center) and service personnel, 190. Sixty persons were employed by Peabody Coal at the Big Sky Mine.

Construction of Units 1 and 2 involved employment of approximately 120 carpenters, 150 electricians, 90 ironworkers, 270 operating engineers, 225 pipefitters and pipefitter welders, and 70 boilermakers. No estimates were available for the number of laborers or other crafts (sheet metal workers, masons, etc.) then employed at Colstrip.

During the week of September 17, 1974, there were approximately 50 job openings at Colstrip, primarily for electricians, pipefitters, and pipefitter welders. No local electricians or pipefitters were available for work.

Mr. Norman Lanemann, Regional Labor Relations Manager for Bechtel Corporation,/9 San Francisco, on October 18, 1974, indicated by telephone that 50 jobs were open for electricians, 34 for pipefitters, and 21 for pipefitter welders. There was almost no demand for other types of craftsmen, since the local unions have been able to keep pace with the need for ironworkers, boilermakers, laborers, etc.

1. Survey of Billings Craft Unions

a. Laborers

Billings local 98 reported a membership of 600 persons, an increase of 150 since the Colstrip construction projects began. Approximately 120 laborers are reported to be working for Bechtel Corporation, with 65 laborers employed by other contractors at Colstrip. The union reported 120 men "on the bench" (unemployed and seeking work). Forty-five laborers are transfers from other locals, although the union states that almost 100% of the laborers employed at Colstrip are Montanans or hold union cards with Montana locals. The Employment Security Division indicated that most laborers are recruited from the immediate area and with little difficulty.

Bechtel's manpower loading forecasts (Chapter 6) indicate that approximately 185 laborers will be needed for the construction of Units 3 and 4 during a construction peak in mid-1976. Even assuming a certain amount of overlap from the construction of Units 1 and 2, the demand for laborers should not exceed local supply. There is an existing pool of unemployed laborers,/10 and, more importantly, the union has relatively open entry requirements. An applicant must pay the requisite initiation fee and monthly dues to obtain and hold a card in the union. There are no apprenticeships, and the union can, if it so desires, quickly expand its membership to accommodate job openings.

b. Operating Engineers

This craft exhibits a pattern similar to that of laborers, with almost 100% of its Colstrip membership being Montana residents. Also, there are Montana operating engineers seeking employment, with 275 reported on the bench by local unions in Billings and Kalispell.

During the week of October 14, 1974, the Billings business office of Local 400 reported employment of 319 members in the Colstrip area. Sixty-one persons were working for Bechtel Corporation, 156 were employed at the Western Energy Company mine, and 102 were working for various sub-contractors. The union reported that all of the men employed at Colstrip are members of Local 400. Seventy-five men were on the bench.

The union noted that unemployment for its membership significantly increases in the winter, since many members work at seasonal jobs such as highway construction. Local 400 has approximately 2,700 members and has jurisdiction over most of Montana. The only other local union of operating engineers is located in Kalispell, with jurisdiction over the far western counties of the state.

Bechtel's manpower loading forecasts project a peak need for approximately 100 operating engineers in mid-1977 (see Chapter 6). Additional operating engineers will also be needed as the mine expands to serve the coal needs of Units 1 and 2 and any other coal contracts Western Energy might obtain. Considering only the construction projects, the need for operating engineers is primarily for site preparation such as building roads, digging foundations, and clearing right-of-way for pipe and power lines. With site preparation completed, the need for operating engineers declines. A few men are required to operate cranes, trucks, and other types of loading and lifting equipment.

Based on the estimated employment needs for the Colstrip projects, there does not appear to be any foreseeable problem in acquiring operating engineers. The local supply of available manpower is relatively large, and the construction manpower needs are low. As the mine expands (with or without Units 3 and 4), the demand for operating engineers will also increase. Some of those working on construction projects may be expected to take mine jobs. However, even if this transfer process does not occur, there should be little difficulty in filling mine jobs. The Employment Security Division has indicated that the operating engineers have been very receptive to opening their ranks for prospective employees at the mines and have actively participated in encouraging the employment of Indians at mining operations.

c. Carpenters

Local 1172 of the United Brotherhood of Carpenters and Joiners of America is headquartered in Billings and has jurisdiction over carpenters in an eleven-county area of southeastern Montana. Union representatives reported 128 carpenters currently employed on construction projects at Colstrip, with Bechtel Corporation employing 91 persons. The local union also indicated full employment of its membership, although seven "floaters" (men from other local unions) were listed as on the bench. The union indicated that approximately 20 men working at Colstrip were from unions outside Montana.

Manpower loading forecasts for Units 3 and 4 (Chapter 6), indicate a peak need for approximately 155 carpenters during late 1976. Assuming that the number of carpenters currently employed at Colstrip are available for work on Units 3 and 4, there would be an estimated local shortage of approximately 27 carpenters. However, local unions elsewhere in the state are reporting some unemployment./11 Unless there is a significant upswing in construction of all types across Montana, local unions in the state should be able to meet projected employment demands at Colstrip.

d. Ironworkers

Local 708 reported 118 ironworkers employed at projects in the Colstrip area during the week of October 14, 1974. Bechtel Corporation was cited as the largest single employer, with 43 ironworkers on the job. No ironworkers were listed as on the bench, and there were eight job openings at Colstrip.

Union representatives indicated that Local 708 had 153 members. The union also estimated that 95% of the ironworkers employed at Colstrip were from Montana.

This latter figure contradicts information provided by the Employment Security Division, whose estimates suggest that 15% to 20% of the Colstrip ironworkers are from outside Montana, particularly western Texas. Respondents from the ironworkers union indicated a state-wide pattern of ironworker shortage./12 Accordingly, there has been greater in-migration to ironworking jobs than to openings in other crafts.

Manpower loading forecasts for Units 3 and 4 (Chapter 6) indicate a need for approximately 120 ironworkers in the fall of 1976. Assuming that the number of ironworkers currently employed at Colstrip will be available for Units 3 and 4, there should be an adequate supply of manpower.

e. Boilermakers

Colstrip construction projects fall under the jurisdiction of Local 599; however, the International Brotherhood of Boilermakers maintains a district business office in Helena which handles the placement of men seeking work. The union reported a total of 115 men working at Colstrip (25 from other states) during the week of October 14, 1974. Five field boilermakers were on the bench, and eight men from outside Montana had applied for work permits from the union. No job openings were reported anywhere in the state./13

Manpower loading forecasts (see Chapter 6) indicate a peak need of approximately 330 boilermakers in mid-1977. The current supply-demand equation for boilermakers is balanced, with little unemployment reported. Approximately 750 men hold boilermaker cards in Montana local unions. However, two-thirds of those enrolled work full-time for industrial firms such as the Anaconda Company and do not routinely work contract construction. The projected demand for oilermakers at Colstrip far outstrips the existing supply of Montana craftsmen. Thus, the construction of Units 3 and 4 would require the importing of manpower.

f. Pipefitters

Local 30, headquartered in Billings, reported employment of approximately 250 pipefitters, steam fitters, plumbers, and pipefitter welders in the Colstrip area. The union had no one listed on the bench and needed approximately 60 men to fill job vacancies at Colstrip. Persons holding journey men or apprenticeship cards with Local 30 accounted for approximately 40% of those working at Colstrip. The remaining 150 men were either travelers (from other local unions) or permit men (those granted a temporary union card to work as a craftsman in the jurisdictional area of the local union)./14

The manpower loading forecasts for Units 3 and 4 project a peak need of approximately 310 pipefitters in mid-1977 (See Chapter 6). Assuming that the number of pipefitters currently working at Colstrip are available for work on Units 3 and 4, there would be a deficiency of at least 60 craftsmen. At present, pipefitter local unions across the state are reporting almost full employment./15 However, a major construction project in Anaconda is scheduled to terminate December 1, 1974, releasing approximately 60 pipefitters.

It appears reasonably certain that the demand for pipefitters at Colstrip will out-strip the supply of Montana craftsmen in this trade. Pipefitting, like boilermaking, is a craft strongly tied to contract constuction and heavy industry. The largest concentrations of pipefitters are attached to locals in Butte (280 men), Great Falls (223), Missoula (232), and Billings (258). Many of these men work full-time for firms such as the Anaconda Company and are not available for construction work. Other members of pipefitter locals are actually plumbers and work for small plumbing and heating contractors throughout the state. Finally, many men living and working in areas such as Missoula or Butte are reluctant to take jobs at Colstrip unless forced to by an absence of work in their home area. Provided local economic patterns do not decline, releasing Montana pipefitters for construction labor, it appears that Colstrip vacancies in this craft will have to be filled by persons from outside the state.

g. Electricians

Local 532, with jurisdiction over the Colstrip projects, reported a total of 175 electricians working at Colstrip. Thirty job openings were reported, with no electricians locally available for employment./16 The union also estimated that approximately 25 of the working electricians were from outside Montana.

Manpower loading forecasts for Units 3 and 4 project a peak need for about 270 electricians (See Chapter 6) in mid-1977. This estimate is approximately 100 men higher than the figures for current employment. Contacts with local unions of the International Brotherhood of Electrical Workers (IBEW) across the state revealed a consistent pattern of full employment. /17 Electricians are in short supply, and it appears doubtful that Local 532 in Billings can meet the required demand for electricians without drawing workmen from outside Montana.

The business agent for Local 532 indirectly substantiated this point in a conversation about the proposed 500 KV transmission facilities. When asked if he anticipated any difficulty in locating 100 to 150 linemen (approximately one-half of the projected work force) for construction, he replied, "No, those guys follow the jobs all over the country. If they know there is a big one out here, they'll come." The business agent with IBEW Local 44 in Butte offered a similar assessment. He also mentioned that transmission line projects currently under construction (the 161 KV line in the Bitterroot Valley) are largely drawing linemen from states other than Montana.

2. Available Manpower

As previously indicated, levels of available manpower vary significantly among the crafts. Laborers and operating engineers are plentiful, and Montana local unions appear able to supply manpower at the levels projected for Units 3 and 4 from their own memberships. The projected need for carpenters also falls within the supply capability of Montana unions.

Ironworkers, pipefitters, and electricians are generally in short supply throughout the state with numerous job openings at Colstrip and high employment levels elsewhere. Boilermakers are currently exhibiting a balanced supply-demand equation although unemployment for approximately 70 men is projected starting December 1, 1974, as construction projects in Anaconda terminate. The ability of Montana unions to supply projected manpower needs for electricians, pipefitters, boilermakers and ironworkers from their own memberships appears doubtful.

If the existing state-wide employment pattern remains relatively constant, the small size of Montana unions and the large manpower demands of the Colstrip projects combine to suggest that construction manpower will need to be imported. The ironworkers may be an exception, since the projected need for this craft is lower than for other crafts.

B. Potential Manpower

The supply of craft manpower in Montana is both greater and more eleastic than indicated in the preceding section. Labor unions have the ability to increase the supply of craftsmen by opening their ranks to apprentices and permit men, and bring in journeymen from other local unions. The number of apprenticeships opened in a local union is formally specified by a national journeyman-apprenticeship ratio. Depending on the craft, this ratio ranges from one apprentice for each journeyman to one apprentice for every seven journeymen.

It is not known how many local unions have apprenticeship openings, if any. However, respondents did indicate that some local unions in the Billings area, particularly IBEW 532, were being asked by the contractors to open more apprenticeships. While the number of apprenticeships is formally specified, the union also has the ability to issue work permits and then, at a later date, initiate the individual into the union as an apprentice.

A major problem in expanding craft membership through apprenticeships is the time required. The adequate training of an apprentice takes years and is not a suitable means for quickly raising the numbers of skilled workmen. Also, unions are often reluctant to expand apprenticeship programs, particularly if the perceived need for workmen appears temporary. As one respondent explained, "The unions are afraid of putting on a lot of apprentices just for [Units] 3 and 4. They're afraid that when it's over, they'll be stuck with a lot of new men and no jobs."

Work permits can be issued to those seeking apprenticeshps or those with existing craft skills. The number of craftsmen in a particular trade is not equal to the number of trade union members. For example, the lumber industry in Montana has large numbers of craftsmen on its payrolls who work as plant electricians, pipefitters, millwrights, etc. Most of these men are members of the sawmill workers or paperworkers' unions and do not hold cards with building trades unions (IBEW, Pipefitters, etc.). In order to work at the Colstrip projects, these craftsmen would need a work permit. It is conceivable that contractors at Colstrip could help meet their manpower needs with craftsmen from the slackening lumber industry if the appropriate work permits were issued./18

Unions lack total control over hiring. If the union is unable to supply the needed manpower, the contractor can hire men such as unemployed sawmill craftsmen "at the gate." These men are then granted union work permits. Then, if union members become available, permits are revoked to open the jobs for union members.

C. Competitive Construction Projects

Major determinants of manpower levels at any one construction project are the number, pay rate, and location of other construction projects in the state and region. Montana building trades unions have relatively small memberships, and a few projects are sufficient to provide full employment. When manpower requirements are greater than can be supplied locally, workmen must be imported. Craftsmen from Western Montana are reluctant to work at Colstrip if they can work close to home. Likewise, a craftsman from Kansas may have a choice between working at Colstrip, Gillette, Rock Springs, or elsewhere. The extent to which workmen can be attracted to Colstrip mainly depends on living conditions and pay rate.

For example, there is unemployment among craftsmen in Missoula, Kalispell and Butte despite job openings at Colstrip. Business agents with unions in those communities indicated that it was difficult to get men to go to Colstrip because "it is too far away," "living conditions aren't so good," and "it doesn't pay." Generally, craftsmen prefer to work at projects close to where they live in order to minimize commuting, travel and lodging expenses, and time spent away from their families. However, if the wages are sufficiently high, some workmen will accept the inconveneinces attached to living and working away from home.

At present, men employed at Colstrip are working 40 hours per week. The absence of scheduled overtime work discourages potential workmen. One business agent said he could easily find 10 to 15 electricians if the contractors were working overtime./19 Another respondent noted, "Bechtel is competing against itself. They're working scheduled overtime on the Bridger project [Jim Bridger Power Plant at Rock Springs, Wyoming] and can't get anyone up here."

If Units 3 and 4 are built, the project would have to compete for manpower with the Bridger Power Plant, a possible expansion at Hoerner-Waldorf, and a continuing expansion of facilities of the Anaconda smelter. In addition, a proposed power plant at Wyodak, Wyoming, may be under construction, an expansion is being planned by Hoerner-Waldorf at its Frenchtown Mill, and Burlington-Northern is proposing a fertilizer plant and gasification complex for McCone County. These projects require large pools of skilled manpower, and each can be expected to influence (or be influenced by) manpower levels at Colstrip.

FOOTNOTES
CHAPTER EIGHT

1. Low, moderate and high estimates of the peak construction and direct permanent population at Colstrip have been developed. The "moderate" estimates have been used in this report.

If 460 construction workers were on site in April 1974, and, if the work force estimated by WECO as 1658 for 1978 are all construction workers, then the boom construction should be 1977-79, based on the assumption that the growth process for Units 3 and 4 is similar to 1 and 2.

If the WECO estimate of 660 is considered to be a low feasible estimate, then a 5% increase over this might be considered a moderate feasible estimate, and a 10% increase might be considered a high feasible estimate for miners, operators and service personnel.

If experience at Rock Springs, Wyoming is useful, the WECO estimates for construction workers could easily be too low. The figure of 1,658 may not be intended to apply to only construction workers. If it does not, then presumably a lower figure, perhaps 1,500, would be a feasibly low figure. 2,000 workers could be a feasibly high figure, while 1,750 construction workers could be a moderate figure.

2. See Footnote 1

3. See Footnote 1

4. See Footnote 1

5. The demand for construction personnel may also sharply drop. However, this is not considered a viable possibility unless a labor dispute should occur.

6. Although there will be considerable tax money forthcoming from the extraction of coal, a lag of two or three years is anticipated before most of this money will be available locally. Even so, some fear that the new demands for increased governmental, educational, and social services may exceed the new monetary supply; thus, coal development may not pay its own way after all.

7. It is the researchers' observation that few realize what all-out development really entails. Most in the study area would accept limited strip mining activity.

8. The Rosebud government and services sector includes the wages and salaries earned by govenment employees of the Northern Cheyenne Indian Reservation and the earnings of employees of the Northern Cheyenne Tribal Council, a non-profit membership organization (Standard Industrial Classification Code 86).

9. Bechtel Corporation is the general contractor for Units 1 and 2.

10. Local unions in Billings, Great Falls, and Butte reported a total of 175 laborers seeking employment.

11. Ten local unions in Glendive, Missoula, Polson, Thompson Falls, Anaconda, Bozeman, Great Falls, Libby, Butte, and Billings reported a total of 100 carpenters seeking employment. Carpenters were most plentiful in Missoula (40), Great Falls (20) and Bozeman (15).

12. The Anaconda local reported 25 job openings. However, the local union in Kalispell reported 22 men on the bench.

13. The Boilermakers Union reported that a gradual lay-off of 70 men is slated to begin December 1, 1974, at construction projects in Anaconda.

14. Permits are issued when a union must meet manpower needs that cannot be filled with union members. Permits are usually issued to persons with experience in the craft (pipefitters previously employed at sawmills who have the requisite skills but do not hold a union card with the pipefitters union) or men seeking apprenticeship. Permits can be converted into union membership or revoked at the union's discretion. The decision to grant union membership or revoke the permit is contingent on job supply and demand.

15. The Butte and Great Falls local unions reported a total of six persons seeking work. Missoula Local 459 reported 47 men on the bench.

16. The estimate of job openings provided by the union is significantly at variance with that provided by Bechtel Corporation (50 electrician openings).

17. The three Butte locals reported a total of 15 men on the bench; three men were seeking work in Great Falls and 15 in Kalispell. Lewistown and Helena reported no one on the bench.

18. In 1977, the year in which Bechtel forecasts an employment peak for Units 3 and 4, the labor contracts in the Montana copper industry are scheduled to expire. Strikes at negotiating time are not uncommon. If the copper industry is struck in 1977, contractors throughout the state will have an opportunity to acquire significant numbers of craftsmen. Moreover, most craftsmen working for the Anaconda Company hold membership in the building trades unions.

19. Overtime is usually paid at twice the normal hourly rate of pay. Depending on the craft and job involved, overtime wage rates range from approximately $11.00 per hour for laborers to over $17.00 per hour for ironworkers.

CHAPTER NINE Alternative Transmission Technology

If Colstrip Units 3 and 4 are built, then additional in-state transmission capacity will be needed, since existing capacity will not accomodate the proposed power plants. If additional lines are to be built, such variables as voltage level and tower design must be decided upon, as well as such alternatives as alternating current (A.C.) or direct current (D.C.) and overhead or underground transmission.

9.1. The Trend Toward Higher Voltages

Voltage levels between 230 and 800 KV are generally called extra-high voltage (EHV). Voltage levels above 800 KV are called ultra-high voltage (UHV). In 1950 the highest transmission voltage in use in the United States was a 287 KV A.C. line. The first 100 KV D.C. transmission line was constructed between the Swedish mainland and Gotland Island in 1954; it carried 20 MW. As demand for electricity grew, higher-voltage transmission became more economically feasible, partly because fewer lines are required. For example, one single-circuit 765 KV line has a load-carrying capacity equivalent to five single-circuit 138 KV lines. Because fewer lines are required when higher voltages are used, less land must be removed from other uses (See Table 9-1). Various power delivery points and routes for Colstrip power were considered by the applicants and by the Bonneville Power Administration (BPA 1974). One route was considered impractical because it passed through the Magruder Corridor. Because other routes were 800 to 900 miles long, the applicants prefer transmitting the power 430 miles to connect with existing 500 KV lines at Hot Springs, Montana, to be transmitted from there to Spokane.

If Units 3 and 4 are constructed, it will be necessary to transmit about 1300 MW of electricity. A suitable voltage level for a load of that size would be a single-circuit 500 KV A.C. line, or ±400 KV D.C., or any higher voltage. However, if a single-circuit line were used, the reliability of service to all customers served by the line would be jeopardized by a fault on the line. For system reliability, a second line would be required.

9.2. D.C. Transmission

High-voltage D.C. (HVDC) transmission is considered to be still in its infancy. However, in 1970, the Celilo, Oregon to Sylmar, California ±400 KV overhead D.C. line, 846 miles long, began operation (U.S.D.I. 1970). Preliminary studies to determine the feasibility of using D.C. for the line were made prior to congressional approval of the D.C. line in 1964; engineering studies of design took an additional four years. The main purpose of the line is to transfer bulk power

TABLE 9-1

LAND UTILIZATION WITH INCREASING VOLTAGES[1]

KV	Minimum Right-of-Way (feet)	Power Transfer With Least Expense in MW (SIL-MW)	Right-of-Way Land Per Mile in Acres	MW Per Acre	Number of 230 KV Circuits Needed for Equivalent Power Transfer
230	75	150	9.09	16.5	1
345	90	400	10.91	36.7	4
500	125	900	15.15	59.4	6
765	160	2100	19.39	108.3	14
1100	180	4100	21.81	188.0	27
1300	200	5900	24.24	243.4	39
1500	220	8100	26.66	303.8	54

[1] All lines are single circuit, without compensation equipment, and utilizing "V" type conduction configuration

from south to north in winter, and from north to south in summer, along the west coast. Converters are used at both ends of the line to convert A.C. power into D.C. and back again. These converters are a major cost factor in D.C. transmission, costing usually from $30 to $38 per KW per terminal, and in some cases costing as much as $43 per KW (FPC 1970). This cost varies as an inverse function of terminal size. For comparison, a comparable A.C. switching station would cost from $7 to $9 per KW per terminal.

The need for filters in D.C. transmission also increases its cost. HVDC converter stations generate strong harmonics--multiple frequencies of 60 cycles. Unless such harmonics are removed by filters on both the A.C. and D.C. sides of the converters, they will be propagated through the transmission network where they can cause inductive interference with communications circuits (Holmborn 1967). Depending on the size and rating of necessary filters, the cost can comprise 15% of the cost of a converter station; therefore, filters are an important consideration in design.

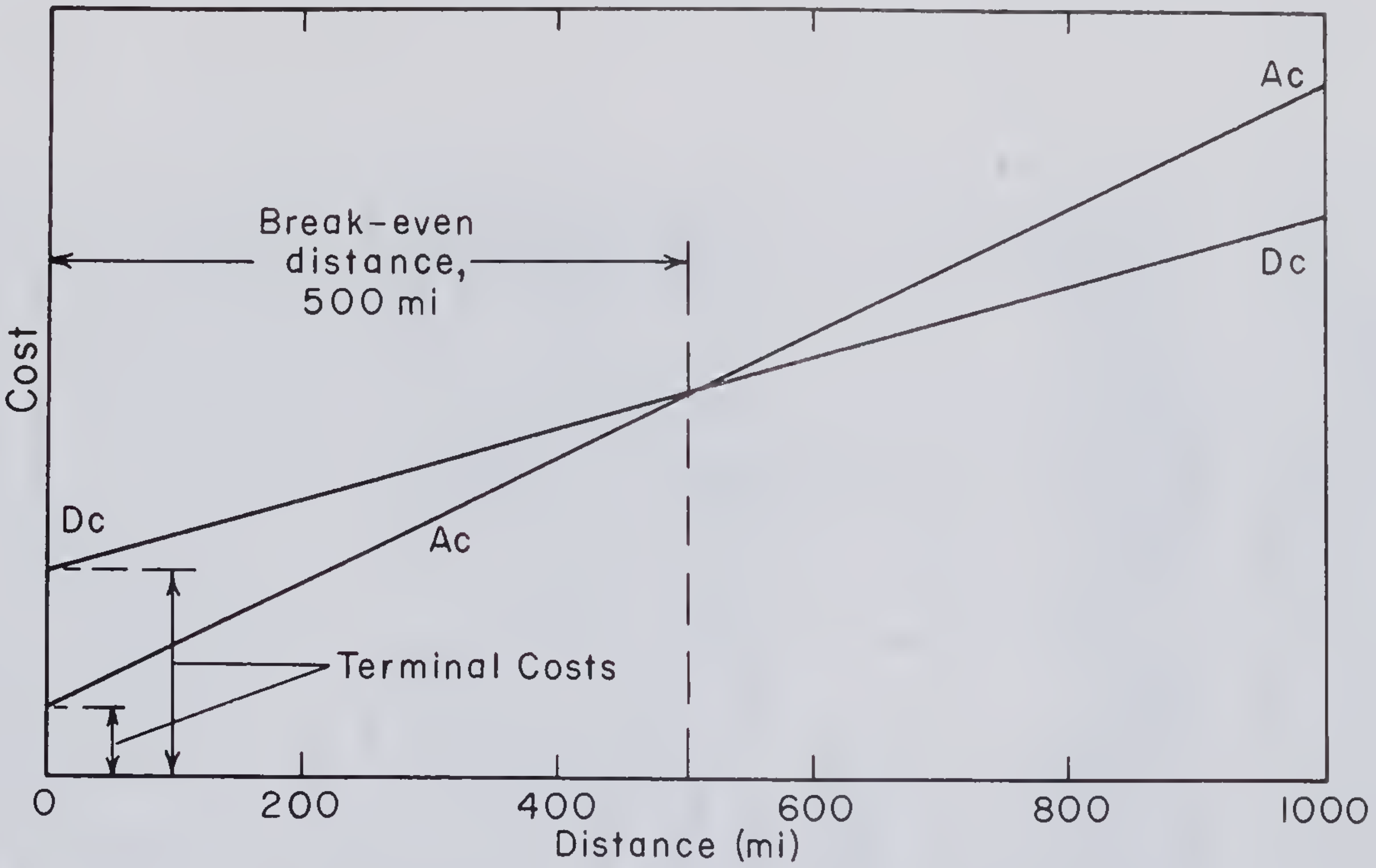
A third factor affecting the cost of HVDC transmission is tapping, or removal of some of the total power load at an intermediate point between the generator and power delivery point, to supply local needs. When HVDC lines are tapped, converters are required at each tapping point. Two tappings are anticipated by the applicants over the proposed 430-mile length of the Colstrip-Hot Springs lines, to supply future energy demands of the state. These tappings will drain about 760 MW from the lines; therefore, of the anticipated 2060 MW generated at Colstrip, about 1300 MW would reach Hot Springs.

Considering these factors, HVDC transmission has been ruled out by the applicants because of cost. Figure 9-1 compares costs of A.C. and D.C. overhead transmission.

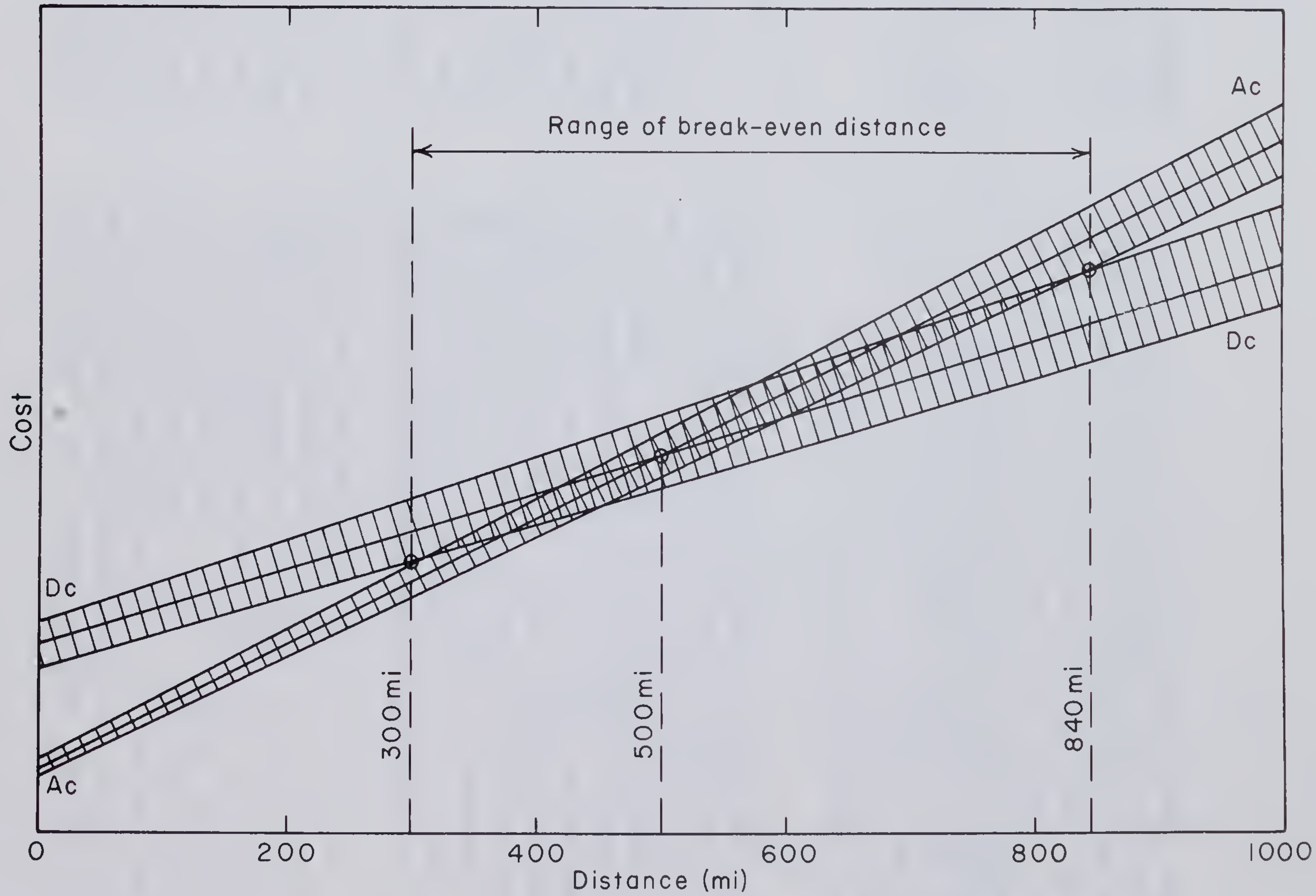
9.3. A.C. Transmission

Because utility companies and others have conducted much research in this area, A.C. transmission is more economical than D.C. at this time. Required terminal equipment, such as lightning arrestors, circuit breakers, transformers, relays, and line compensation equipment, is well designed and in a more advanced stage of research than D.C. equipment. Tapping of an A.C. transmission system is much easier and less costly than tapping an HVDC system.

Interconnection of new lines with the existing Western Systems Coordinating Council (WSCC) grid system--which is composed, with one exception, of A.C. lines--is much easier for A.C. than D.C. lines. Transmission grid systems, such as that administered by WSCC, consisting of the interconnection of load centers and generating centers, provide greater reserve capacity. Reliability of all involved lines also increases when



COMPARATIVE COSTS OF AC AND DC
OVERHEAD LINES VERSUS DISTANCE



EFFECT OF VARIATION OF COSTS
ON BREAK-EVEN DISTANCE

FIGURE 9-1 (Kimbark, 1973)

an adequate grid system is established, but with increased reliability comes the possibility that some regions may have to suffer the impact of the construction and continuing presence of more transmission lines than the region actually needs. Montana's present energy needs can be adequately supplied by a 230 KV grid.

9.4. Underground and Overhead Transmission (UGT and OHT)

Historically, the development of electric power systems has been based on the use of high-voltage overhead lines for bulk power transfer. Use of underground transmission (UGT) lines has been limited to short distances and areas where right-of-way costs are high, such as downtown areas. The technology for overhead transmission (OHT) lines, even at high voltage, is greatly advanced in relation to technology for UGT of equivalent load-carrying capacity, with the result that costs for UGT are much higher than OHT. Adequate UGT cables have not been developed; necessary compensating equipment is costly. A 345 KV UGT line, thirty miles long, in a suburban area, presently costs around $690,000 per mile, compared with $119,000 per mile for a 345 KV OHT circuit (FPC 1970). In addition, the OHT line would have more than twice the capacity of the UGT line--1050 MW as opposed to 484 MW. The UGT line would require an additional $3,760,000 for compensation and terminal facilities not necessary for OHT. Cost per MW-mile for the 345 KV UGT line would be $1,685, while the OHT line cost would be only $113 per MW-mile (FPC 1970).

Because of the state of the art, the amount of time required for developing an engineering design for UGT would be much higher than for OHT.

9.5. Summary of Cost Values

A comparison of overhead D.C. and A.C. transmission costs for the proposed Colstrip project, which includes two intermediate delivery points, shows that D.C. transmission can be three to six times higher (not considering the time element). If the proposed project would extend 430 miles without intermediate tapping, the cost could be 0.9 to 1.9 times higher for D.C. (See Figure 9-1). It should be noted that cost studies require detailed analysis in the initial planning period of a project.

The cost comparison for overhead and underground transmission for this project is shown in Table 9-2.

9.6. Engineering Alternatives for the Colstrip Project

Considering the alternatives discussed above, from the standpoints both of economics and of available technology, the most feasible transmission alternative for the proposed project

TABLE 9-2

COST COMPARISON OF OVERHEAD AND UNDERGROUND TRANSMISSION FOR THE COLSTRIP PROJECT

		Cost of OHT ($000 Per Mile)	Average Cost	Cost of UGT ($000 Per Mile	Average Cost	Ratio
A.C.	500 KV System	76.5--306	155.1	637-972	818	5.27
D.C.	±400 KV System (which can be equivalent to 500 KV without tapping)	58 --160	95.7	622-936	759	7.93

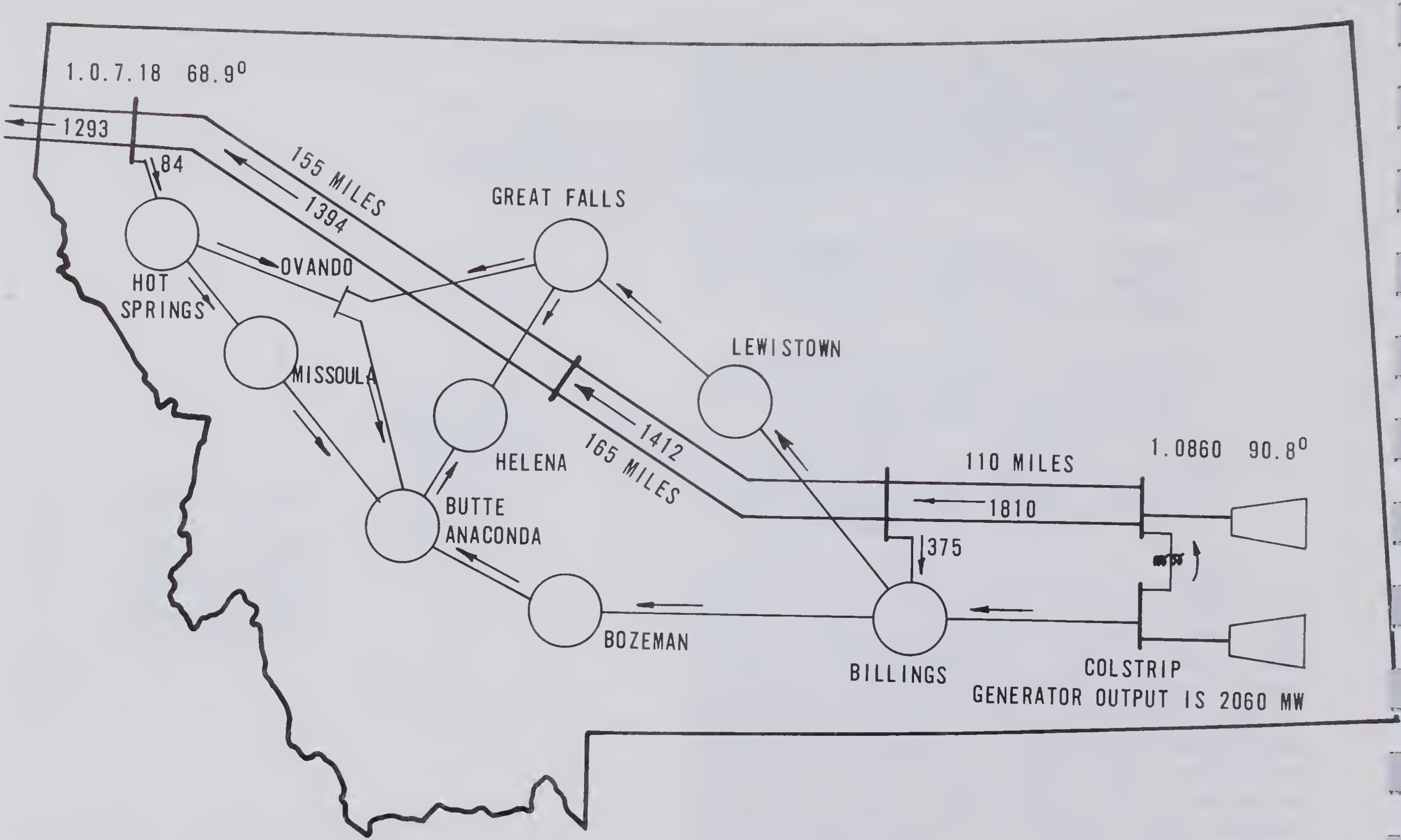
consists of twin 500 KV OHT A.C. lines. Assuming this configuration, there are three routes from Colstrip to Hot Springs (shown in Figures 9-2, 9-3, and 9-4, respectively) which can be considered technically possible and provide for two intermediate tappings.

A. Colstrip to Billings to Helena to Hot Springs, with tappings at Billings and Helena (Figure 9-2).

B. Colstrip to Billings to Great Falls to Hot Springs, with tappings at Billings and Great Falls (Figure 9-3).

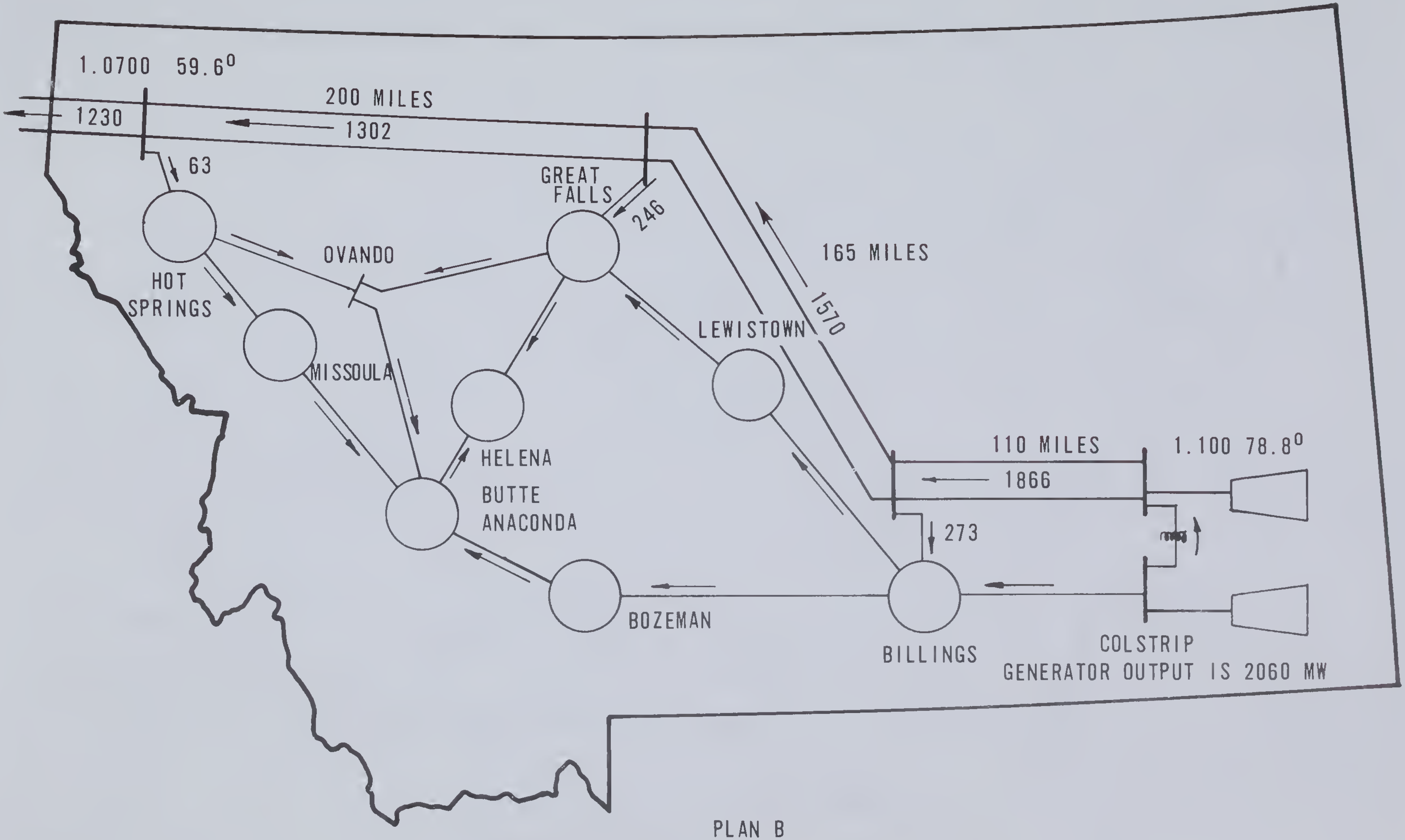
C. Colstrip to Billings to Butte-Anaconda to Hot Springs, with tappings at Billings and Butte-Anaconda (Figure 9-4).

Route A, the shortest route, would involve the least economic cost. Route B would be 11.1% more costly than A, and route C would be 12.5% more costly than A. The higher costs of B and C would result from providing stability for those routes equivalent to the stability of A. The engineering feasibility of using these alternatives are equal except for cost. Therefore, selection of an optimum route among these alternatives will be based on the comparison between environmental impacts and installation and operation costs.



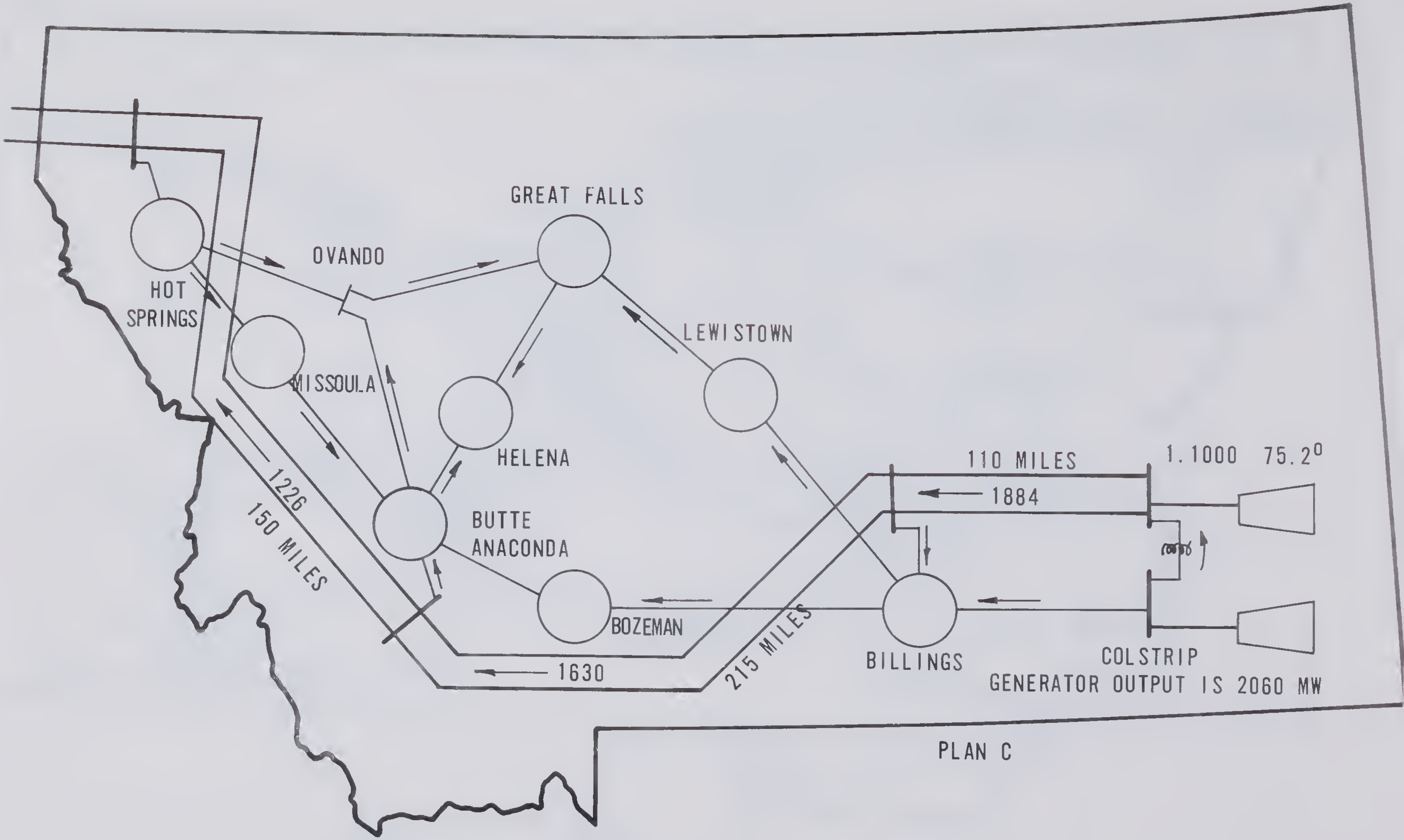
PLAN A
MEGA WATT FLOWS IN 500 KV SYSTEM FOR 1979-80

FIGURE 9-2



PLAN B
MEGA WATT FLOWS IN 500 KV SYSTEM FOR 1979-80

FIGURE 9-3



MEGA WATT FLOWS IN 500 KV SYSTEM FOR 1979-80

FIGURE 9-4

CHAPTER TEN Proposed Line Characteristics and Calculated Impact Magnitude

10.1. Line Characteristics

A 300 foot right-of-way has been proposed to contain both of the proposed 500 KV lines. The applicants have also proposed two tower structures (Figures 10-1 and 10-2). The self-supported tower structure (Figure 10-1) has a base approximately 28'x28'. The guyed tower (Figure 10-2) is supported by four guy wires, which may be placed from 70' to 75' from the center tower structure. Each line would consist of twelve conductors (Figure 10-3), each 1.140" in diameter. Four conductors would form one bundle; there are three phases in high-voltage A.C. transmission, and each phase would consist of one bundle. Minimum clearance from conductor to ground would be 37'. There would be an average of four to five towers per mile.

10.2. Construction and Maintenance

10.2.1. General Description

10.2.1.1. Construction

Construction can be categorized into the major areas of construction survey and staking, clearing, road construction, tower construction and erection, stringing of conductors, and clean up and restoration.

A. Survey and Staking

This is required for all rights-of-way, tower sites, roads, substations, and other engineered or controlled facilities assoicated with the transmission line project such as communication sites, staging areas, helicopter landing areas, wire stringing sites, and other.

The surveyors and their equipment are the first on the scene. The crews are small, about three or four people.

B. Clearing

This includes all operations needed to open up the sites described above to enable construction and future operation of the planned facilities. Clearing consists primarily of vegetative removal or modification such as crushing. Man-made objects such as buildings or fences may require modification, moving, or demolishing. Sometimes other natural barriers are cleared such as rock outcroppings.

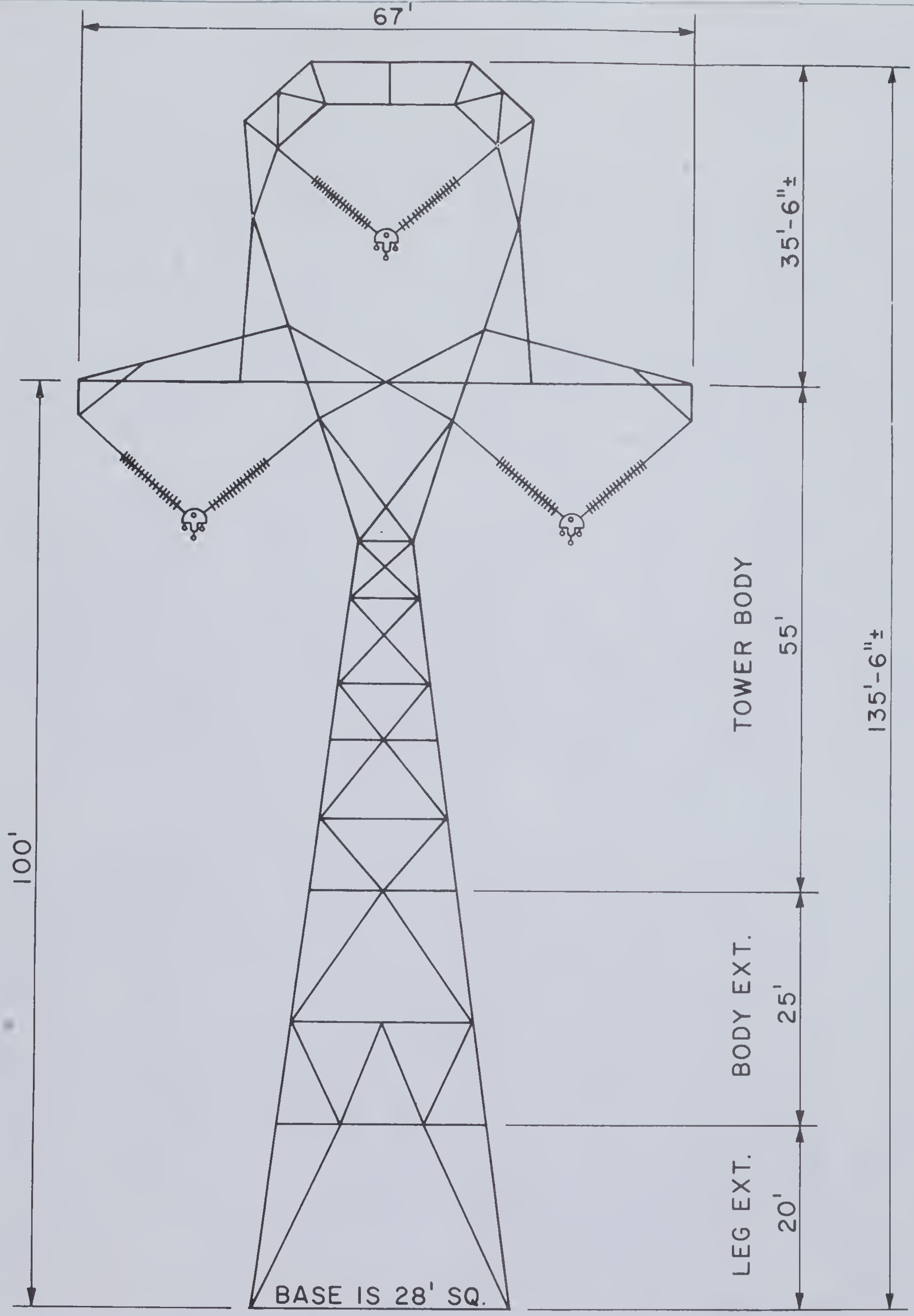
Equipment ranges from hand tools to large bulldozers. Crew sizes may vary from three or four to 24 or 30.

Substations are completely cleared and are usually built in presently open areas.

Road clearing requires complete clearing of paths from 25 to 100 feet wide or more depending on road type, use, and terrain. Normally minimal road clearing is five feet from the toe of the fill to 10 feet from the top of the cut.

C. Road Construction

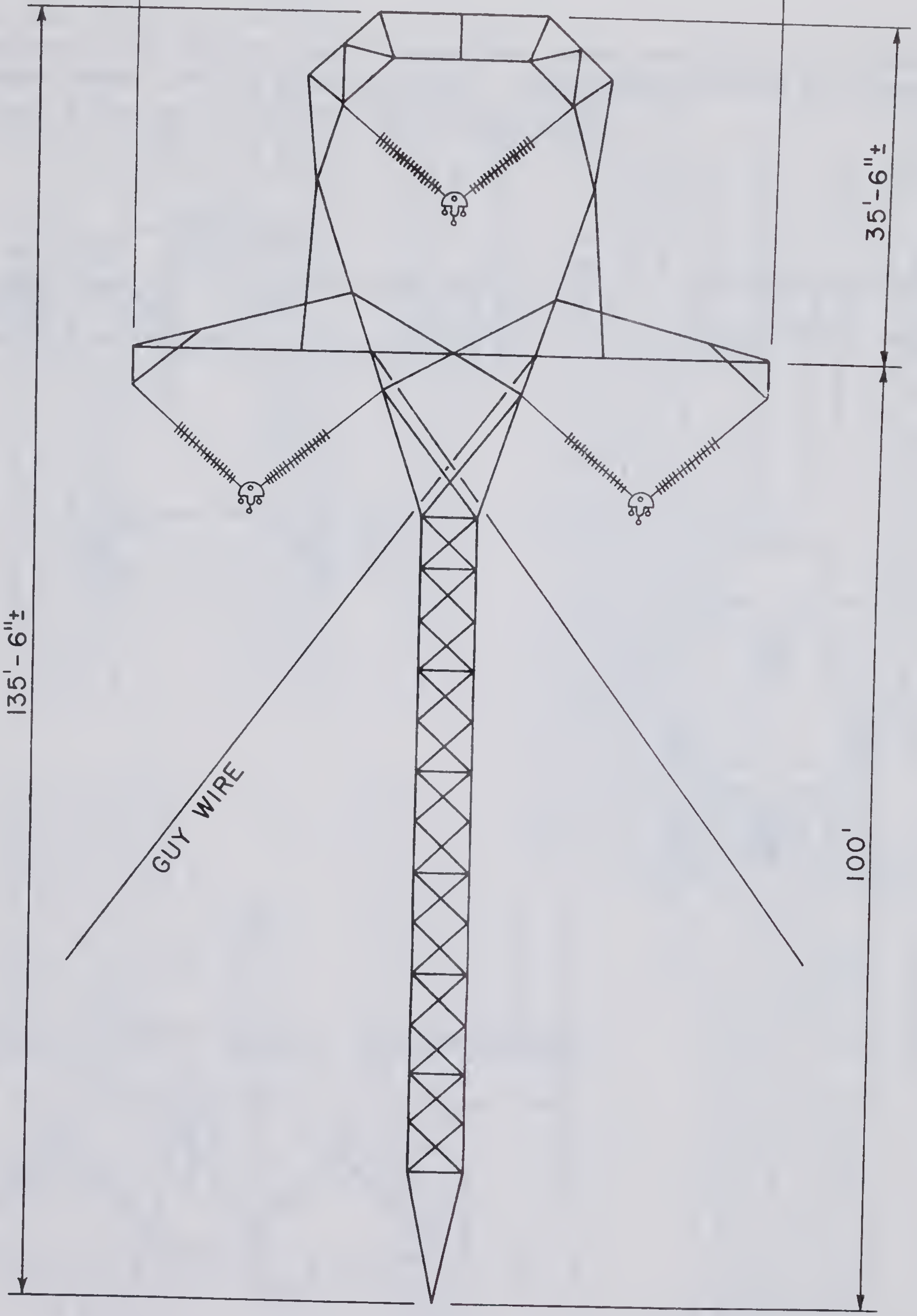
Permanent existing roads may require widening, additional gravel, more drainage, or other



500 KV SINGLE CIRCUIT TOWER – SELF SUPPORTED DELTA CONFIGURATION

(Westinghouse, 1973)

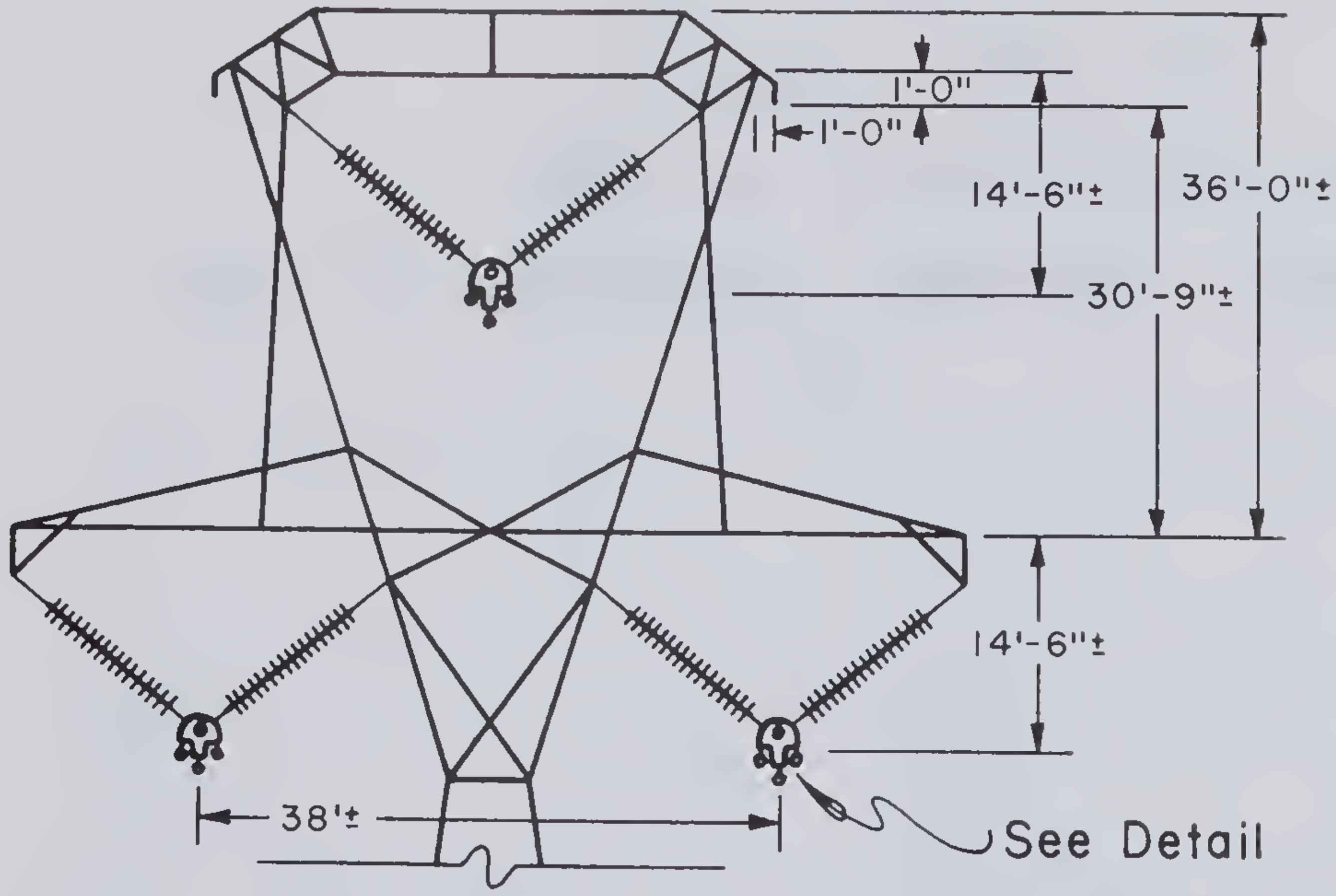
FIGURE 10-1



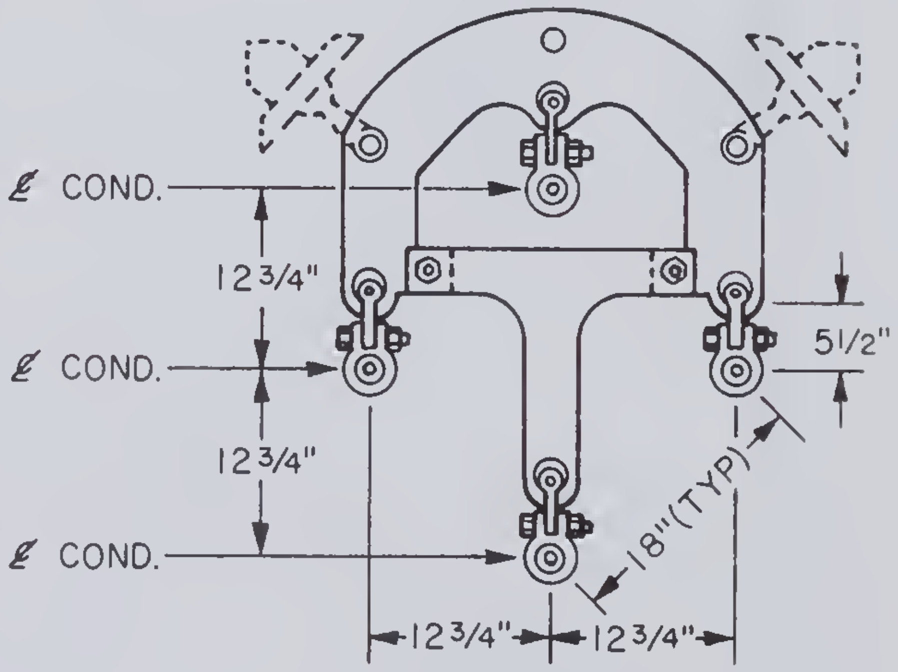
500 KV SINGLE CIRCUIT TOWER - GUYED
DELTA CONFIGURATION

(Westinghouse, 1973)

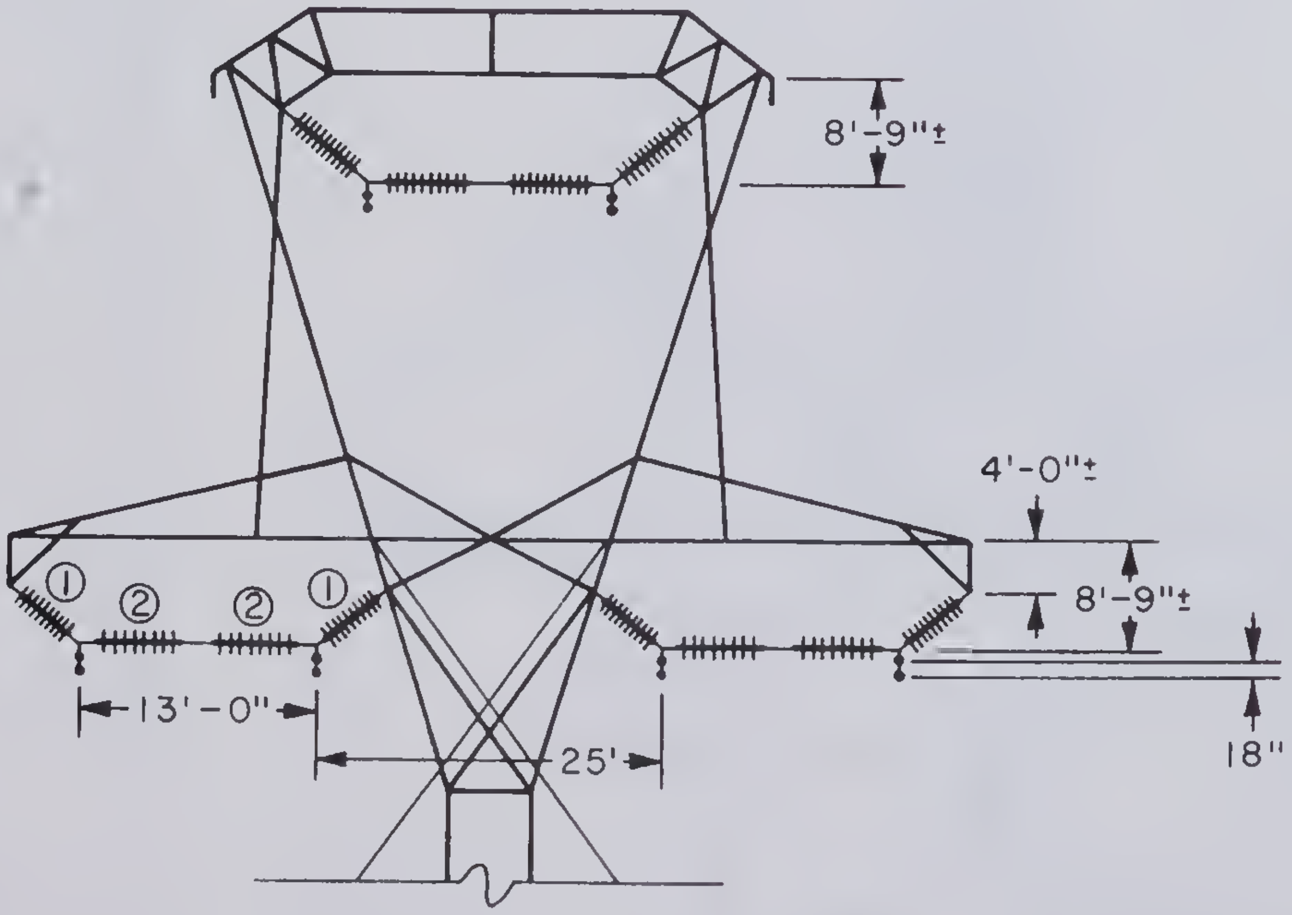
FIGURE 10-2



500 KV SINGLE CIRCUIT ARRANGEMENT



DETAIL



① 14 Insulator rings

② 11 Insulator rings

230 KV DOUBLE CIRCUIT ARRANGEMENT

Same tower top as 500 KV tower (Proposed for one line from Colstrip to Broadview and convertible from two 230 KV circuits to one 500 KV circuit.)

IGU 10 (W ing se '73)

reconstruction because of the line project. New permanent roads may be needed. Temporary roads are usually required for line construction.

Equipment and workmen are those normally used for rural road construction.

D. Tower Construction and Erection

This includes tower component assembly, tower assembly, installation of footings and guys, tower erection, and counterpoise installation (tower grounding). After tower sites are cleared, excavation for footings is done. Crews range from a few to a dozen or more and may include those employed in other construction stages.

E. Conductor Stringing

Insulator strings are installed on the towers, conductors are pulled in from wire reel sites, splices are made, and final tensioning and connections of the conductors completed.

Wire pulling sites are required approximately every three miles along the line for wire trailers, pullers, tensioners, and associated equipment. These must be set up in line with the towers.

F. Clean Up and Restoration

Clean up is a part of each construction phase, but final clean up and restoration or rehabilitation is whatever construction is needed to restore the various sites and rights-of-way to as nearly the original conditions as possible.

10.2.1.2. Maintenance

Maintenance includes all functions needed to keep the lines and associated facilities in operation throughout their lifetime. Road maintenance is required during and after construction of the lines. Other maintenance includes line patrol or inspection, vegetative management, and structural and electrical maintenance. These operations are carried out both on a planned and emergency basis.

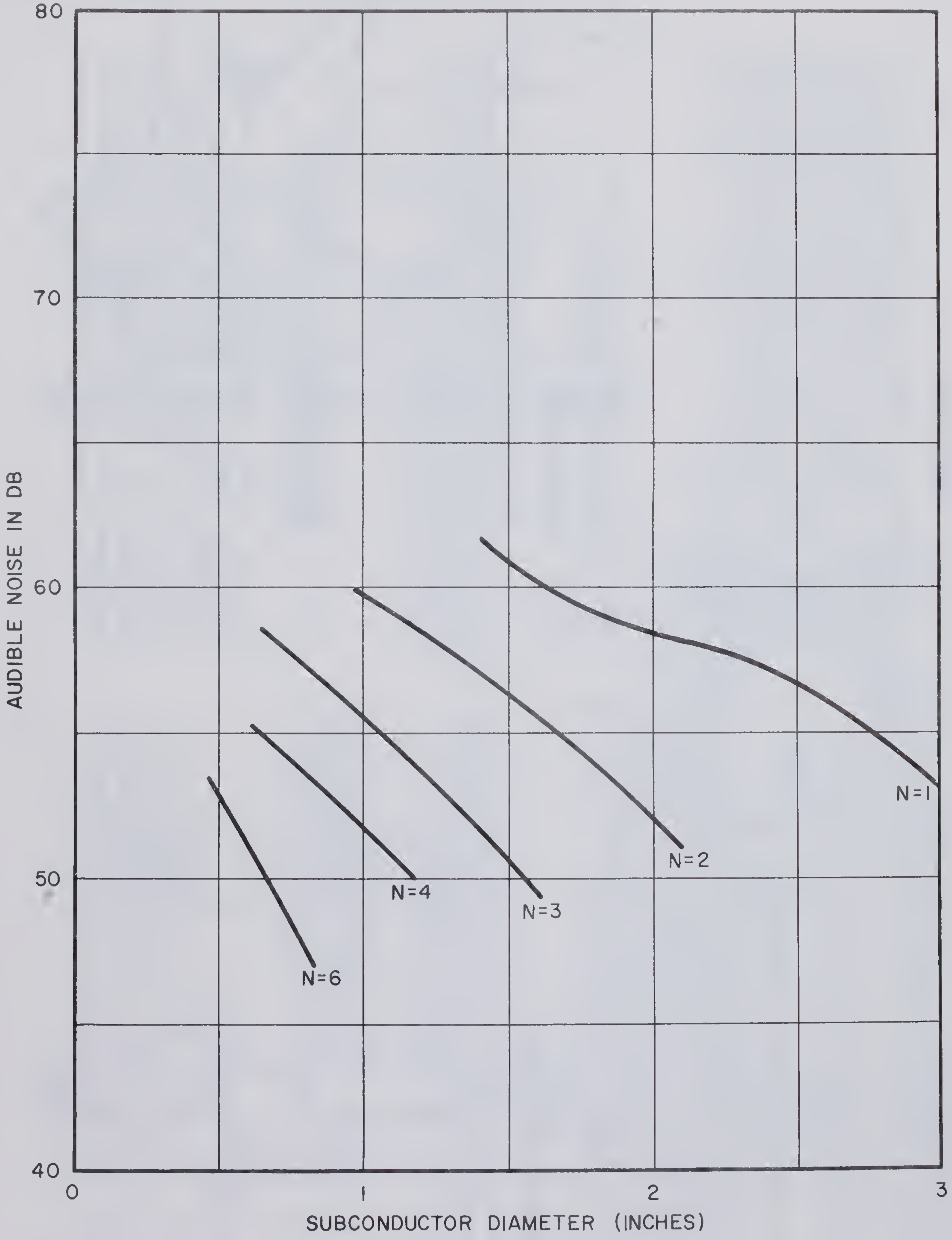
10.3. Calculated Impact Magnitude

10.3.1. Audible Noise

At 100' from the outer conductor, audible noise may reach the 51 db level (see Figure 10-4). According to Figure 10-5, which delineates expected public response, audible noise of 51 db may not create a problem.

10.3.2. Radio and Television Interference (RFI and TVI)

The effect of transmission line noise on different forms of communication, such as A.M. band radio, citizen's band radio, police, highway patrol, and highway department communication channels, and television reception, varies with the distance of receiving antennas from the line, background noise, and strength of signals. For television reception, interference also depends



AN AT 100 FEET FROM OUTER PHASE OF 500 KV LINES
UNDER RAIN, BASED ON CAGE TESTS

(IEEE, 1970)

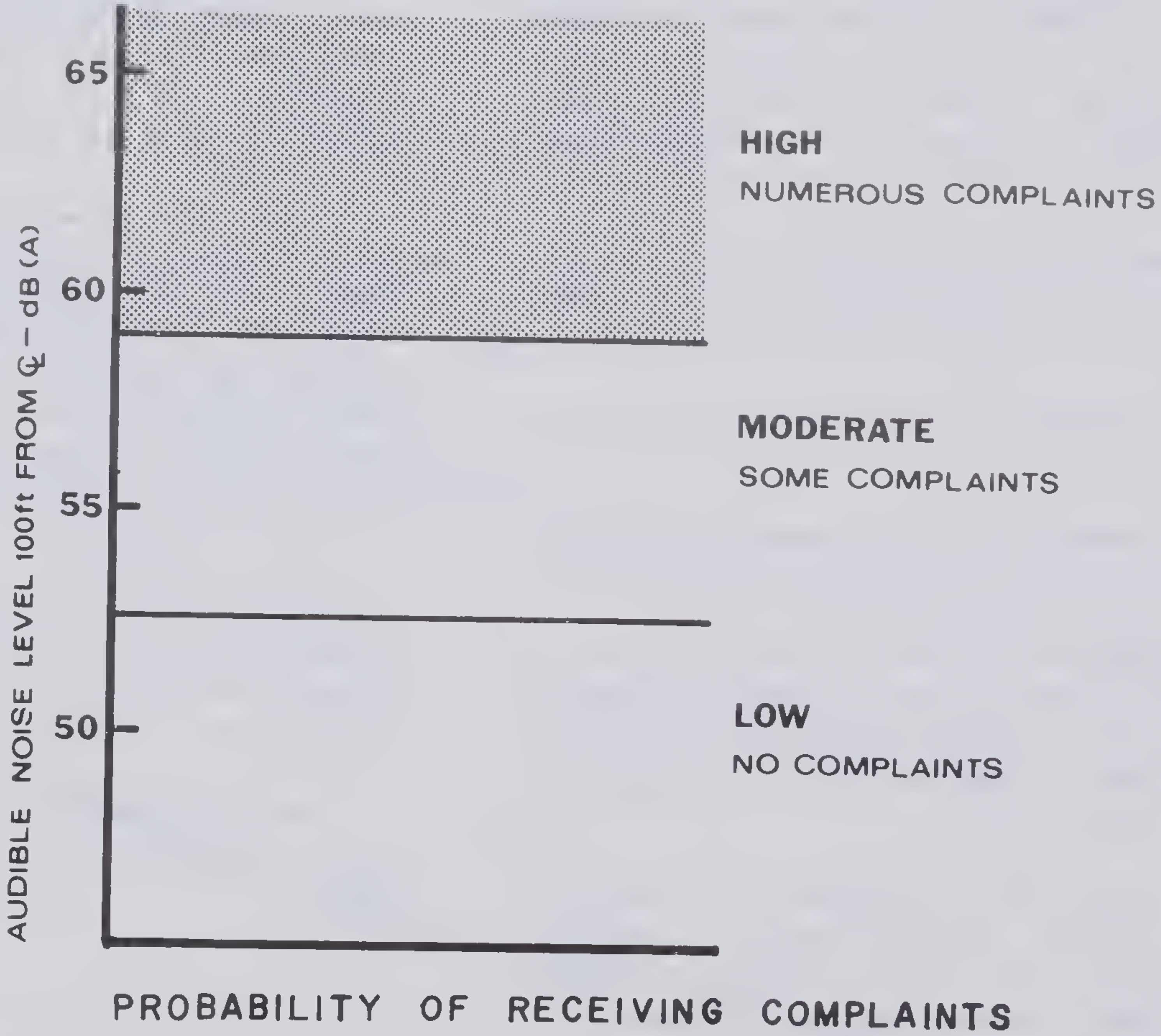

AUDIBLE NOISE LEVEL 100ft FROM ℄ – dB (A)
65
60
55
50
HIGH
NUMEROUS COMPLAINTS
MODERATE
SOME COMPLAINTS
LOW
NO COMPLAINTS
PROBABILITY OF RECEIVING COMPLAINTS

FIGURE 10-5

upon the direction of the antenna in relation to the lines.

Prediction of radio frequency interference (RFI) and television interference (TVI) would involve a case-by-case study. The signal-to-noise ratio (SNR) is the factor that determines the extent of interference, and to find SNR for a given case it is necessary to know levels of both communication signal and noise. Figure 10-6 predicts noise level, in decibels, under four methods of caluclation, for varying distances from the lines. These four methods are as follows:

Method I: Upper values represent foul weather conditions (i.e. precipitation) and lower values represent fair weather conditions.

Method II: Assumes fair weather conditions 50% of the time.

Method III: Assumes foul weather conditions 50% of the time.

Method IV: Upper values represent foul weather conditions and lower values represent fair conditions (the test location and assumptions were different for method IV than for method I).

The signal level for the radio's receiving antenna depends mainly on the distance from the transmitting station, the power capacity of the transmitting station, and other factors such as frequency, background noise, etc. The Federal Communication Commission has established standards for reception quality. For a radio station's primary service area, which includes the area within a ten-mile radius of the station transmitting antenna, the minimum signal level is 63.5 db (at 1mv/m reference). The secondary service area, within a 30-mile radius of the transmitting antenna, must have a minimum signal level of 54 db.

Television reception is defined as Class A and Class B reception (shown in Table 10-1) and involves factors such as channel number and direction of the TV antenna. Therefore, the coverage area is not specified in the table.

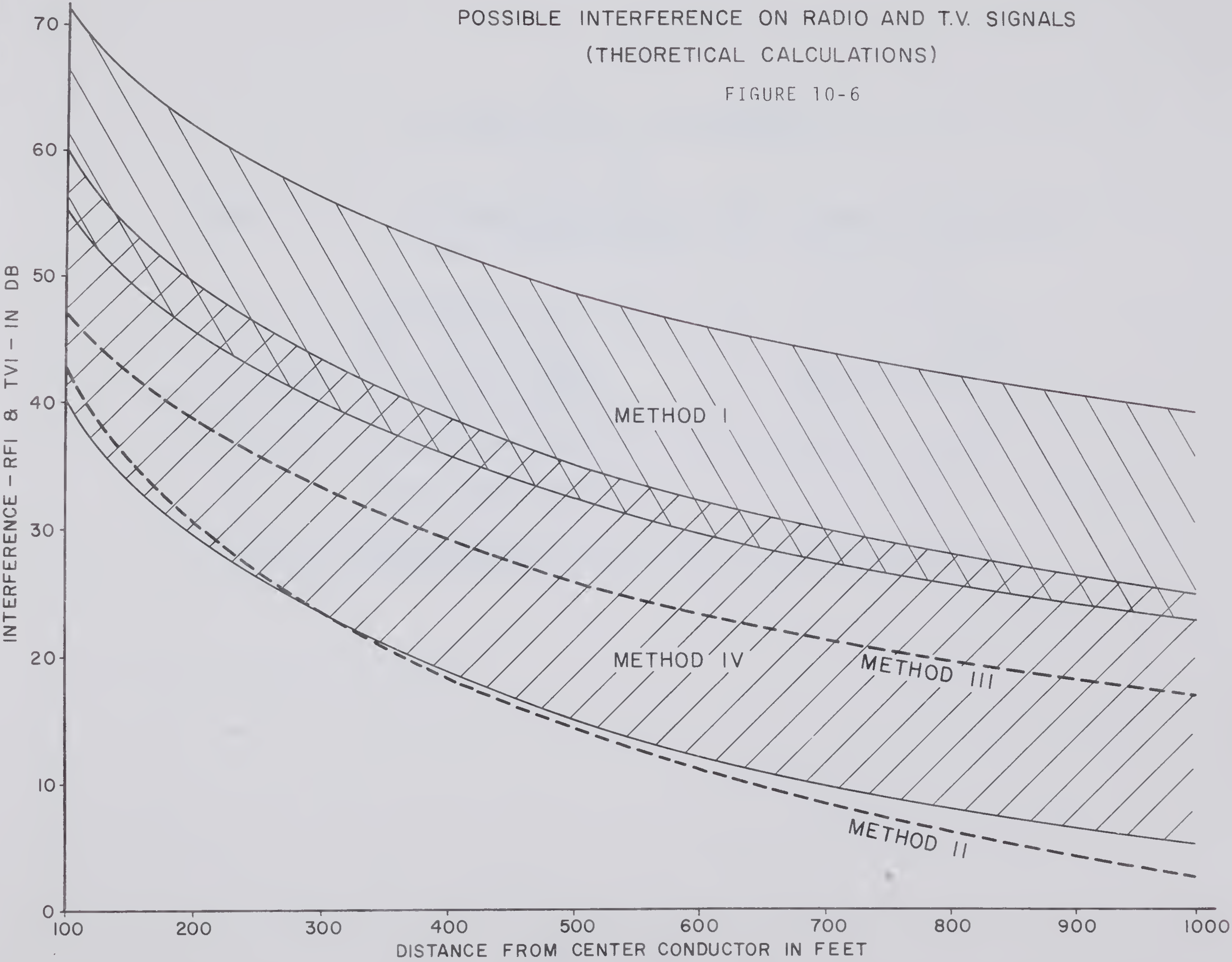
The above discussion is further explained by the following example. Assume a particular place located 1000' from the center line of a transmission line has radio reception of 55 db (secondary coverage). Figure 10-6, Method I indicates a noise level in foul weather of 40 db and 23 db in fair weather. Therefore, the SNR for foul weather will be 55db-40db=15db, and for fair weather will be 55db-23db=32db.

Table 10-2 evaluates RFI for various SNR levels. For the example just given, fair weather reception quality is "A" grade while in foul weather the quality falls to an "E" grade.

SNR for TVI can be calculated in the same way. Table 10-3 evaluates various SNR levels for TVI.

10.3.3. Electrostatic and Electromagnetic Induction

Current passing through high-voltage trans-



POSSIBLE INTERFERENCE ON RADIO AND T.V. SIGNALS
(THEORETICAL CALCULATIONS)
FIGURE 10-6

TABLE 10-1

SIGNAL STRENGTH OF TELEVISION COVERAGE AREAS

Class	Channel No.*		
	2-6	7-13	14-69
A	68 db or more	71 db or more	74 db or more
B	47 db or more	56 db or more	64 db or more

*The reference level for all channels is microvolts per meter.

TABLE 10-2

SIGNAL TO NOISE EVALUATION FOR RADIO FREQUENCY INTERFERENCE

Grade	Evaluation	Signal to Noise Ratio
A	Excellent	32 db or higher
B	Very good, background unobtrusive	27 db to 31 db
C	Fairly satisfactory Background evident	22 db to 26 db
D	Background very evident speech understandable	16 db to 21 db
E	Speech understandable with severe concentration	11 db to 15 db
F	Unintelligible	10 db or lower

TABLE 10-3

SIGNAL TO NOISE EVALUATION FOR TELEVISION INTERFERENCE

Grade	Evaluation	Signal to Noise Ratio
A	Excellent	37 db or higher
B	Very little interference	28 db to 36 db
C	Tolerable reception	17 db to 27 db
D	Interference very evident and annoying	4 db to 16 db
E	Intense interference	-12 db to 3 db

mission lines can induce current in conducting objects beneath or near those lines. This induction is of two types: mutual inductive coupling occurs between power lines and long conductors, such as fences, which are parallel and close to the lines and are not properly grounded; capacitive coupling occurs between EHV power lines and a conducting object, such as a vehicle, located on some insulating material, such as rubber tires.

Mutual inductive coupling between the proposed lines and nearby fences, even those within the right-of-way, is not expected to produce hazardous current. The theoretical worst-case values has been calculated at 0.6 mA (mill Ampere). Figure 10-7, which shows the effect on humans of varying levels of current, shows that the effect of 0.6 mA would not be severe.

The worst case of capacitive coupling would occur between the lines and a semi-trailer, and would theoretically result in a value of 8.4 mA, slightly above the safe let-go level for women and children (See Figure 10-7).

10.3.4. Mitigating Measures to Reduce Adverse Impacts of the Lines

1) While selecting centerline, locate lines away from radio and television transmitters and receivers.

2) Select tower heights to avoid direct interference to transmitters.

3) Take utmost care while stringing the conductors to avoid creating burrs and scratches on the conductors, since such irregularities increase the incidence of audible noise, RFI, TVI, etc.

4) Provide higher clearances in those areas where the use of heavy machinery is anticipated, to minimize electrostatic induction effects.

5) Fixed objects, such as fences and gutter lids, in close proximity to the line, need good electrical grounding, also grounding should be periodically checked to insure its performance and condition.

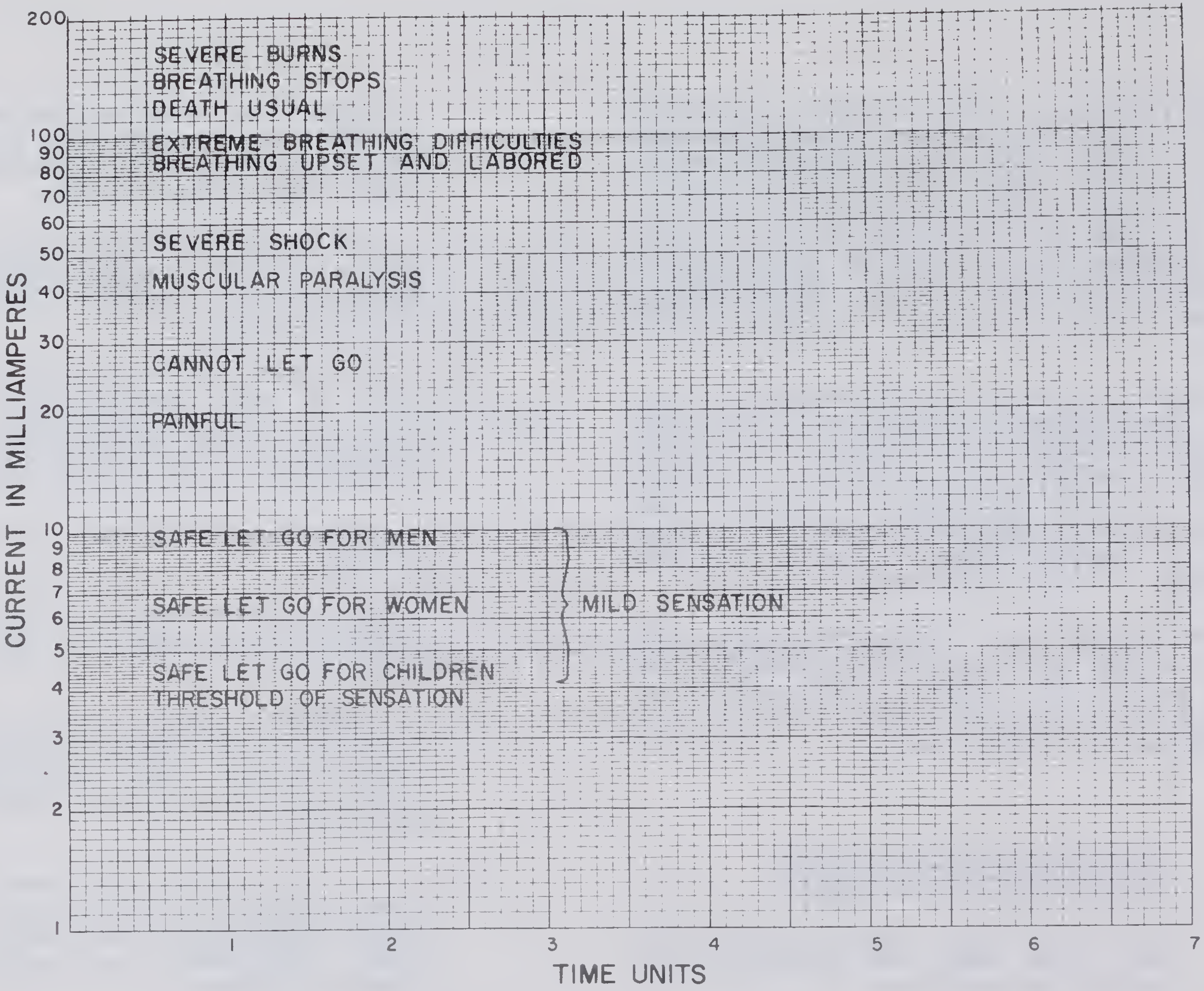
6) Avoid piling anything under the conductors.

7) Do not refuel vehicles with gasoline underneath the lines, or park them there.

8) If sprinkler systems are used in the vicinity of the lines, make sure the water does not touch the conductors, even under such adverse conditions as heavy wind.

9) Do not try to climb steel towers or guy wires, or try to destroy insulator rings or any related parts, since faulty insulators will increase the possibility of hazardous incidents.

10) When building new fences within the right-of-way, make sure the fence is well grounded.



EFFECTS OF CURRENT ON HUMANS

Source: Popular Science, 1972 and Rene-Coma IEEE Paper

FIGURE 10-7

Up to this time the applicants have not selected the conductor for the transmission lines. The conductor (it's diameter and resistances) is the most important part for all electrical radiations. In order to minimize electrical radiation impacts, the recommendation of conductor size will be made by the Department in the final EIS.

10.3.5. Future Monitoring and Supervision

If the proposed lines are approved, after they are fully energized an instrumentation and line supervision program will be developed to monitor electromagnetic, electrostatic, RFI, TVI, and any other possible effects of electrical radiation. If warranted, corrective steps to mitigate or eliminate these effects should be taken. A program of periodic supervision will be developed. New construction in the vicinity of the lines will be checked for grounding and safety. If additional safety measures are required, landowners will be advised individually.

CHAPTER ELEVEN Transmission Study Area Inventory and Impact Analysis

11.1. Natural Environment

11.1.1. Geology and Physiography

11.1.1.1. Inventory

Montana's physiography may be separated into five categories: mountains, foothills, basins, plains, and alluvial lands. These categories can be further classified according to certain predominant physiographic characteristics, such as slope, relief, and roughness as follows:

MOUNTAINS--High-elevation lands of large relief.

M-1. Low to mid-elevation mountains with broken slopes.

M-2. Low to mid-elevation mountains with smooth slopes.

M-3. Mountains with parallel drainages resulting from imbricate overthrusting which has repeated layers of resistant and nonresistant strata.

M-4. Mid-elevation, high-relief mountains of soft rock, containing landscapes with significant areas of bedrock mass failure features.

FOOTHILLS --Lands of low to moderate relief on mountain flanks.

F-1. Steep, hilly, smooth foothills of moderate relief. Mainly moderately dipping sedimentary beds, with minor areas of weakly dissected, volcanic, rocks.

F-2. Nearly level to gently undulating broad plateaus capped by gravel or resistant sedimentary rock, or clayey, unconsolidated Tertiary sediments or glacial Lake Missoula sediments. Steep breaks along drainages. Physiographically similar to P-1, plains benchland, and where these units occur adjacent to one another the separation is somewhat arbitrary.

F-3. Very steep, broken lands of high relief formed by steeply dipping sedimentary beds that form hogback ridges.

F-4. Well dissected, undulating gravels and dipping shales and siltstones. Physiographically closely related to P-2, rolling plains uplands.

BASINS--Broad valleys enclosed by mountains, containing unconsolidated deposits exclusive of flood plains and low terraces.

B-1 Gravelly, sandy alluvial fans and terraces and glacial outwash surfaces. Mostly gently sloping.

B-2. Undulating to hilly glacial moraine. Physiographically related to P-4, glaciated plains.

PLAINS--Lands of generally low relief, underlain mainly be gently dipping sedimentary rock strata. Includes lands of moderate relief formed by erosional dissection of these rocks.

P-1. Poorly dissected plains benchland. Broad, nearly level or undulating benches several miles to scores of miles wide, with short, steep breaks along drainages.

P-2. Rolling plains uplands. Well dissected, rolling shale uplands formed by the erosional dissection of soft sedimentary rocks of uniform resistance to erosion. Low relief.

P-3. Badlands of moderate to high relief formed by dissection of soft bedrock, usually adjacent to major streams.

P-4. Glaciated plains. Undulating to rolling, poorly dissected uplands that have been subjected to continental glaciation.

P-5. Highly dissected, interbedded sediments of varying resistance to erosion. Moderate relief with narrow, flat-topped ridges, steep valley walls, and narrow alluvial bottoms. Related to P-2, rolling plains uplands, but has greater relief.

P-6. Hogbacks formed by differential erosion of dipping beds of varying resistance to weathering and erosion. Relief low to moderate, and localized.

ALLUVIAL LANDS--Floodplains and low terraces affected by flooding and shallow water table.

A-1. Floodplains and low terraces. Well drained; water table relatively deep.

A-2. Floodplains and low terraces with high water table, and marshes; wet areas which contain ponds and swamps.

The physiographic subdivisions described above may be regrouped according to their excavational requirements or "physiographic hazard." These are ranked on a scale of one to five, with one representing essentially no access road construction and site leveling, and five representing extreme impact.

1. Physiographic units A-1, B-1, and P-1. No earth moving would be necessary. Impacts and constructional precautions are minimal.

2. Physiographic units B-2, P-4, and P-6. Local stretches of road would be required, but lengths can be minimized by careful road and tower siting. Locating good roads and tower sites is relatively easy.

3. Physiographic units F-4, A-2, and P-2. Some difficult areas would require continuous roads, but there are occasional opportunities to minimize road construction by taking advantage of level terrain. Length of roads is approximately equal to the length of lines. In A-2, wet alluvial lands, wheel ruts represent a special form of undesirable earth disturbance which may result in artificial water channelization and accompanying erosion.

4. Physiographic units M-2, M-3, P-5, and F-1. At worst, this terrain requires continuous, lengthy roads and tower site leveling. However, with very careful siting and favorable circumstances, overall impacts could be reduced, for long stretches, to the level of 2. The overall length of roads would exceed the length of transmission lines.

5. Physiographic units M-1, M-4, M-5, F-3, and P-3. Extensive, continuous road construction would be necessary, with the length of roads much greater than the length of lines, frequently by a factor of two or more. Maximum depth and width of earth would be disturbed due to very steep hillsides. This extreme is well illustrated by the access road along the 1973 MPC 230 KV transmission line across the Little Wolf Mountains, about 15 miles west of Colstrip.

11.1.1.2. Impacts

A. Impacts of Transmission Lines

A direct impact of transmission line construction is loss of soil due to removal, burial, and erosion that accompanies access road construction and tower site preparation. The more irregular and steep the terrain, the more severe these impacts are.

In areas of inherently unstable slopes, construction and related activities may cause hill slope failure, with possible personal injury, damage to property, damming and siltation of streams, landscape scars, soil loss, and creation of bogs or ponds.

Certain geologic terrains, frequently local in extent, are inherently unfavorable to revegetation of excavated sites. These include areas of badlands, clinker, and erosion prone regolith (subsoil). Accurate assessment of potential for hillslope failure and revegetative inhibition has limitations. Some areas represent localized hazards, while others represent hazards that are more widespread. Extreme care and minimal surface distrubance and road excavation, with possible use of helicopters, may eliminate the possibility of these impacts, even in inherently unfavorable terrain.

Transmission lines may locally interfere with exploitation of geologic resources, causing inconvenience, precluding the mining of some areas, or presenting a safety hazard to operation of large equipment. Existing mines, mining prospects which show potential for development in the near future, and oil and gas wells should be avoided. Limited surface mining can be done safely beneath transmission lines, and transmission lines present no direct obstacle to underground mining. Some deposits, such as coal, may be sufficiently valuable to later justify moving any transmission lines built over them. Low value or small deposits may well be rendered marginal or uneconomical if mining them should require relocation of the lines.

Transmission lines and construction roads may lessen or destroy the aesthetic appeal or scientific value of specific geologic features.

B. Potential Seismic Impacts on Transmission Lines

Earthquakes are dramatic examples of a dynamic geologic process. Earthquake intensity is a qualitative indicator of the violence or energy released by a quake as determined by its visible effects upon people and man-made structures in any given locality. Magnitude is a logarithmic measure of the energy released by a quake. Maximum intensity and magnitude correlate only roughly because they evaluate different properties (Table 11-1). Shocks of magnitude 5.0 (Richter scale) or below generally do not cause great damage.

TABLE 11-1

MAXIMUM INTENSITY AS RELATED TO MAGNITUDE OF SHALLOW EARTHQUAKES

MAGNITUDE (Richter Scale)	INTENSITY (Modified Mercalli Scale)
2	I-II
3	II-IV
4	IV-VI
5	VI-VII
6	VII-IX
7	IX-X
8	X-XI
8.5	XI-XII

Earthquake hazard evaluation is partly earthquake prediction and partly evaluation of local response to an earthquake. Damage may result from the earth vibrations alone or from secondary events such as landslides. Table 11-2 lists earthquake related hazards.

1. Seismic History of Montana

Montana includes a portion of the intermountain seismic belt, which is one of the more active earthquake zones in the United States (Smith and Sbar 1974). Although thousands of tremors occur each year, most are too small or remote to be destructive.

Montana earthquakes have been recorded for slightly over a century. Therefore, earthquake distribution patterns in Montana before the 1860's are essentially unknown. It is reasonable to conclude that numerous earthquakes have occurred in the past where large faults and fault scarps appear today.

Since the 1860's, more than 1,000 earthquakes have occurred in Montana, but only a few caused extensive damage (Scott 1936 and Stewart et al. 1964). Most known Montana earthquakes, including all the major ones, have occurred west of the plains. Four areas which have been particularly active are: 1) the Helena vicinity, 2) the Three Forks area, 3) the Flathead Lake area, and 4) the Hebgen Lake area. Major shocks (intensity VII or greater) which have occurred are shown in Table 11-3.

Earthquakes seldom occur singly. Two patterns of occurrence predominate: 1) one main shock followed by numerous smaller aftershocks, and 2) a series of tremors (swarm) without any one outstanding shock. The Hebgen Lake shock is an example of the first type. There was one main shock, not preceded by a foreshock, but with hundreds of less intense aftershocks which continued for months. The Helena shocks more closely resemble the second pattern; a swarm of numerous quakes occurred prior to and after the strongest shocks (Scott 1936; Murphy et al. 1964).

2. Assessment of Risk

In evaluating the seismic risk to the proposed transmission line, earthquake occurrence and secondary effects as shown on Table 11-2 must be considered.

All hazards presented in Table 11-2 exist between Colstrip and Hot Springs. Therefore, to minimize the chances of earthquake-caused damage to the transmission system, some care must be exercised in determining its location.

Algermissen's seismic risk map (Algermissen 1969) divides the United States into four risk zones, three of which occur in Montana. Although this map is general, it is possibly the most realistic predictive device available for determining the 50 to 100 year hazard. More detailed maps and predictions of earthquake occurrence within smaller areas are less reliable.

Commenting on earthquake prediction in southwestern Montana, Ross and Nelson (1964) state, "Clearly the period for which accurate data are available is too short for prognostications as to future earthquake activity." (page 27). This conclusion applies to any limited area. However, these authors go on to say:

TABLE 11-2

EARTHQUAKE DAMAGING EFFECTS

PRIMARY CAUSES	CONTRIBUTING FACTORS	DAMAGING EFFECTS	EXAMPLES
I. Earth Vibration (vertical & horizontal Accelerations)	1. None	Structures damaged	(all large earthquakes).
	2. Unconsolidated rock or man-made fill amplifying earth vibrations	Structures damaged	Greater structural damage in mined areas during Helena earthquakes of 1935.
	3. Unstable or thixotropic material	Ground breakage and mass movement	Anchorage, Alaska in 1964.
	4. Unstable slope	Landslides, mudslides	Madison canyon slide in 17 Aug 59 earthquake.
	5. Loose rocks on steep slopes	Rock fall	Closure of Lombard RR Tunnel in 1925 earthquake.
	6. Existing bodies of water	Flooding by seiche waves, tsunami, dam failure, stream blockage, etc.	Creation of Quake Lake in 17 Aug 59 earthquake, waves in Mississippi River during Missouri quakes of 1811-1812.
II. Earthsurface	7. Reactivation of surface faults	Damages roads and structures built over the break.	Roads damaged in 17 Aug 59 earthquake.

(Coffman and vonHake 1973)

TABLE 11-3

MAJOR MONTANA EARTHQUAKES

Date	Location	Intensity (Modified Mercalli) Scale	Remarks
27 June 1925	Three Forks	VIII	Many buildings damaged, rock slide blocked Lombard RR tunnel.
12 Oct. 1935	Helena	VII	A few structures damaged.
18 Oct. 1935	Helena	VIII	Strongest of series -- many buildings damaged or destroyed including new high school two dead.
31 Oct. 1935	Helena	VIII	Two dead, additional damage to many buildings.
23 Nov. 1947	S. Madison Co.	VIII	A number of buildings damages.
31 Mar. 1952	Flathead Lake Area	VII	Wells cracked and chimneys fell.
17 Aug. 1959	Hebgen Lake	X	Strongest shock recorded in Montana; buildings destroyed, roads offset, shoreline of Hebgen Lake altered, 23 dead. Waterwells as far away as Florida affected.
1 April 1969	Flathead Lake Area	VII	Damaged chimneys, windows, and a few structures.

> "One may venture the suggestion that earthquakes strong enough to attract marked attention and to do some damage are to be expected to reoccur in or near southwestern Montana sufficiently often so that they should be taken into account in planning houses and other structures in the region." (p. 27).

The occurrence in western Montana of several large earthquakes in this century and the widespread recent faulting (Pardee 1950) indicate continued seismic activity for the next 50 to 100 years. Based on known seismic activity during the past century and the occurrence of recent fault scarps, western Montana will continue to have strong earthquakes with the most numerous and intense shocks occurring in the region, between Helena and Hebgen Lake.

11.1.2. Hydrology

11.1.2.2. Inventory

Surface waters in the study area include streams, lakes, reservoirs, and irrigation canals. The largest streams are the Yellowstone, Bighorn, and Missouri Rivers east of the Continental Divide, and the Clark Fork and Flathead River west of the Divide. Lakes and reservoirs include Flathead Lake, Canyon Ferry Reservoir, and many much smaller bodies of water up to several square miles in area.

Availability of surface water is strongly subject to seasonal fluctuation. Surface water is most abundant in May and June, when rains and snow melt frequently swell streams to as much as 100 times their low flow volumes. By late summer, many minor streams, as well as small stock ponds, are dry. Irrigation reservoirs are usually greatly drawn down by that time of year. Locally, some streams are severely dewatered for irrigation purposes.

A number of ephemeral lakes occupy Lake Basin and Comanche Basin, two large undrained areas northwest of Billings. These lakes are usually reduced to marshy areas by midsummer, and dry up completely by late summer.

11.1.2.2. Impacts on Water Quantity

Forest clearing causes increased stream discharges and alters the timing of runoff peaks. The adverse impacts could include increased and possibly prolonged flood peaks. Corridor and road clearing on floodplains may also contribute to flooding.

11.1.2.3. Impacts on Water Quality

The increased stream discharge and alteration of the timing of peak runoff, resulting from forest clearing, can increase stream channel erosion. The impact of transmission corridor clearing is probably small, relative to other, more widespread disturbances, such as urbanization, clearcut logging, and construction of roads and highways. However, some small watersheds, including severely burned or overdeveloped basins, may presently be in such critical condition that additional vegetative disturbance is undesirable. Watersheds are specifically managed for municipal use are a special type of drainage basin where haphazard development is in conflict with water management.

Water temperature of small streams is significantly increased when extensive shade vegetation is removed from the banks. Hence transmission line corridors should not parallel small streams where shade vegetation is high enough to necessitate its being cut. The corridor should neither run adjacent to these streams nor frequently cross their meanders.

Increased turbidity and siltation of surface waters, which result from disturbance of topsoil and vegetation can persist for months or years. Stream siltation is most severe downstream from points where streams are forded by vehicles, and especially where bank excavation is performed. Corridor and road clearing or floodplains may influence stream channel changes and bank erosion.

Increased nutrient additions to surface waters, commonly associated with siltation, may contribute to eutrophication, especially of small, poorly drained lakes.

11.1.2.4. Other Impacts

Vegetation removal within several hundred feet of snow-water measurement stations may alter snow-accumulation characteristics of the site, the historical basis required for making accurate stream flow forecasts, and also impair the usefulness of the previous records for evaluation of climatic trends.

11.1.3. Soils

11.1.3.1. Inventory

Soils of the study area were delineated using relief, climate, geologic structures, or geomorphic processes. The soils are classified as follows:

Soils of the Mountains

1) Soils developing in material weathered from noncalcareous consolidated rocks other than granites on steep or very steep mountain slopes with significant outcroppings of rock; in material weathered from permeable limestone bedrocks on steep or very steep

mountain slopes with areas of rock outcroppings.

2) Soils developing from material weathered from noncalcareous consolidated rocks other than granites on steep or very steep mountain slopes (in areas of higher rainfall than included in #1 above); in material weathered from calcareous rocks in the Belt Group on steep to very steep mountain slopes; in material weathered from Boulder Batholith granites on steep to very steep mountain slopes.

3) Soils developing from clayey glacial deposits in steep mountain valleys and in material weathered from limestone bedrock on very steep mountain ridges.

4) Soils developing in loamy or clayey material weathered from soft shales and siltstones in rolling to steep mountain basins.

5) Soils developing in loamy material weathered from consolidated bedrock on very steep alpine ridges and adjacent subalpine slopes.

Soils of the Foothills

1) Soils developing in loamy material weathered from folded, consolidated sedimentary and basic igneous rocks on hilly to steep uplands and steep lower valley sideslopes.

2) Soils developing in gravelly alluvial deposits of tertiary age on nearly level to sloping high benches, alluvial fans, and steep escarpments; in loamy material weathered from consolidated, gently dipping sedimentary rocks on undulating to hilly plateaus and high ridges; in clayey unconsolidated tertiary sediments on nearly level benches and steep escarpments; in silty lacustrine deposits on nearly level benches and steep breaks.

3) Soils developing in loamy material weathered from consolidated sedimentary rocks on steep to very steep hogback ridges.

4) Soils developing on gravelly alluvial deposits of tertiary age in high precipitation areas on nearly level to sloping high benches and alluvial fans; in loamy or clayey material weathered from soft shales and siltstones on undulating to rolling uplands.

Soils of the Plains

1) Soils developing in sandy to clayey material weathered from sandstones and shales on nearly level benches.

2) Soils developing on clayey material weathered from clay shales on undulating to steep uplands.

3) Soils developing in loamy to clayey material weathered from shales on steep to very steep, highly dissected badlands.

4) Soils developing in clayey to loamy glacial deposits on undulating to rolling uplands.

5) Soils developing in clayey and loamy material weathered from interbedded unconsolidated and consolidated sediments on well dissected uplands, narrow level ridgetops, and steep valley slopes.

6) Soils developing on clayey material weathered from interbedded steeply dipping consolidated and unconsolidated sedimentary rocks.

Soils of the Basins

1) Soils developing in stratified alluvial deposits on nearly level alluvial fans and high stream terraces; in sandy and gravelly glacial outwash deposits on nearly level outwash terraces, fans, and steep terrace escarpments; in silty alluvial fans and stream terraces.

2) Soils developing in volcanic ash-capped glacial till deposits on undulating to hilly uplands.

Soils of the Alluvial Lands

1) Soils developing in highly stratified alluvial deposits on stream floodplains and low terraces.

2) Soils developing in highly stratified alluvial deposits on stream floodplains and low terraces with significant areas of shallow water tables.

11.1.3.2. Impacts

A. Impacts of Soils on Transmission Lines

The soils themselves could be a constraint against transmission lines, and soil properties must be considered in right-of-way selection. For example, rough, broken land generally contains fragile, shallow soils that are unsuitable for transmission line rights-of-way due to the high costs associated with building roads. Areas of hard, massive rock at or near the surface are unsuitable for the same reason.

Mass failure hazards, shrinking/swelling clays, and high water tables render a site unsuitable for tower foundations because of the very high cost involved. These constraints can be overcome or at least mitigated by careful corridor selection and tower placement within the corridor and by adhering to proper construction methods.

B. Impacts of Transmission Lines on Soils

Disturbance of the soil mantle results in varying degrees of erosion, depending on the nature and severity of the disturbance and the inherent erodability of the soil. Man's activities often disrupt the dynamic equilibrium of the landscape and initiate or accelerate the natural erosional process. In evaluating this project, erosion will be considered significant when it results in lowered on-site productivity to the extent that efforts to restore a site to its predisturbance state are impaired or there is a high probability that eroded material will move into surface waters, lowering off-site water quality.

The impacts of transmission line construction, operation, and maintenance on the soil resource are important factors to consider for this impact statement. There are four aspects of transmission lines that will have an impact on soils.

1. Location and Construction of Tower Foundations

Since the physical presence of a tower will not cover a large area (30 feet square or 70 feet square, depending on tower type), the effect on site productivity is slight. However, construction and tower erection activity in the area surrounding the foundation can be significant. The impact on productivity and subsequent reclamation efforts will range from slight to severe, depending on the revegetation potential of the soil.

2. Location and Construction of Access Roads, Staging Areas, Storage Areas, and the Area Around the Foundation During Erection of the Towers

Access roads and staging areas would create the most significant impacts on the soil resource during the construction phase. Construction of roads will disturb soil over the largest total area and with the greatest severity, resulting in the loss of productivity and the off-site sedimentation of surface water. Careful construction and location of the roadways can minimize this impact in many areas. Staging areas have the same impacts as roads but in a more concentrated area.

The likelihood of access roads and staging areas construction and use generating sediment pollution of downslope surface waters is a function of:

1) The slope's inherent erosion potential;

2) Slope gradient;

3) Length of time the soil surface remains bare of protective vegetative cover, and

4) Proximity of the disturbed area to surface drainage channels.

The long term effects can be reduced by practices such as reseeding, draining, and location procedures which avoid erosive soils and surface drainage channels. The short term risks during and shortly after construction are largely unavoidable. Soil characteristics that limit suitability for roads and staging areas are those that limit revegetation potential for erosion control plantings and reclamation. Trafficability, relative to intensity and season of use, would result in erosion, associated sedimentation risk, and loss of site productivity. Movement of heavy equipment through mountainous areas could possibly have a tremendous erosion impact in some areas.

3. Electrical Characteristics of the Line

The impact of the electrical characteristics of an operating line on the soil immediately under and around the line have not been investigated. Research is needed prior to making any definitive assessment of the nature and extent of impacts on the soil resource by an operating transmission line.

4. Permanent Roads for Maintenance and Emergency Repairs

The roads needed for maintenance and emergency repairs, after initial construction, will be stabilized, drained and reseeded (Westinghouse 1973). The most important considerations for soils are the season of use and the type of equipment. Movement of heavy equipment through mountainous areas during the spring runoff period can be regarded as an extreme but realistic possibility which would have a tremendous erosion impact in some areas.

11.1.4. Vegetation

11.1.4.1. Inventory

Vegetation within the study area results from diverse topography, soils, climate, and past history of land use. The elevational and climatic gradients determine the kinds of vegetation that dominate. The "Existing Vegetation Types Map" shows the 29 vegetation types included.

11.1.4.2. Impacts

The impacts of the proposed transmission line on vegetation vary with vegetation type, physiography, adherence to environmental guidelines, and other factors. The applicants have indicated that strict environmental guidelines will be followed, and the following impact assessment will be based on that assumption. However, less than ideal situations that could conceivably occur will be addressed.

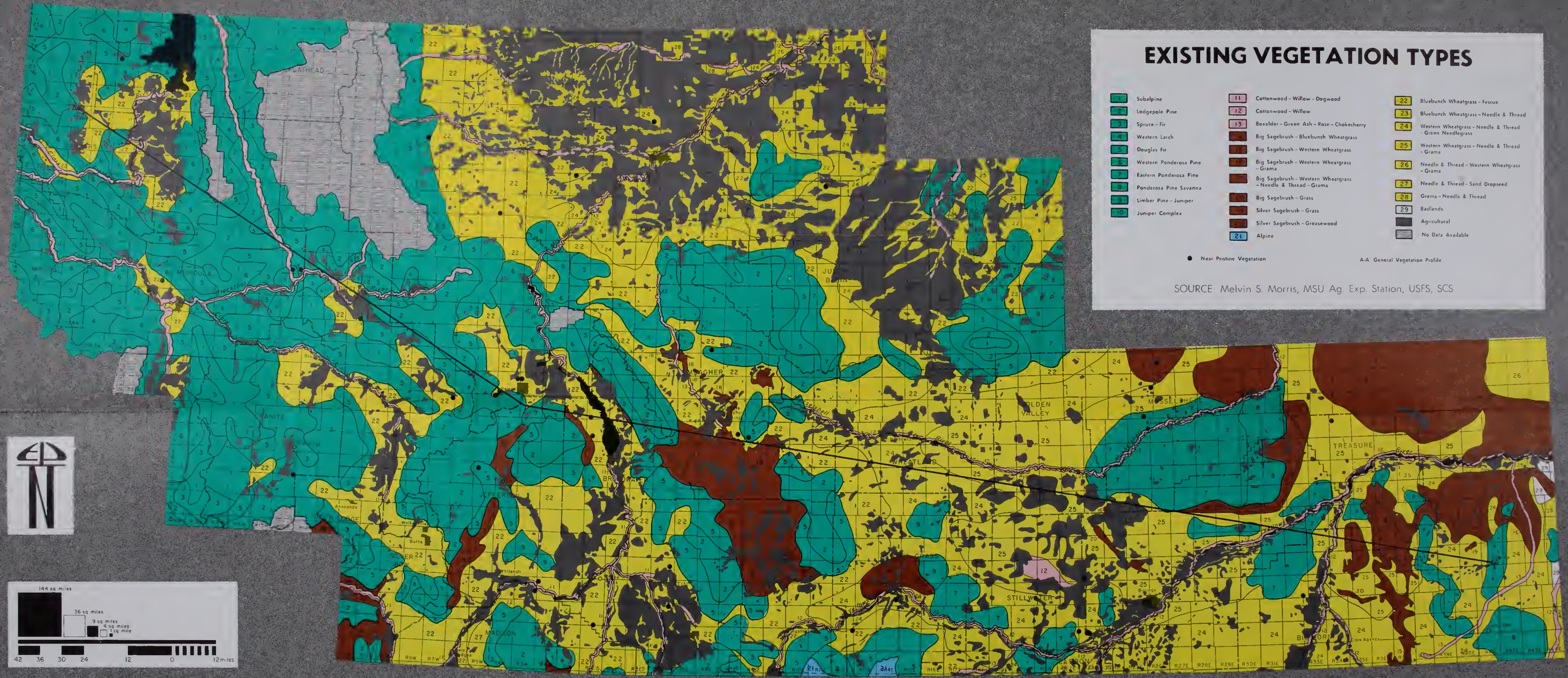
A. Construction Phase

1. Vegetation Removal

The removal of vegetation from transmission line right-of-way access roads, and other areas such as concrete batch plants and staging areas cannot be avoided in most cases.

Forested areas usually present the most severe problems of vegetation removal. In order to accommodate the large, heavy equipment needed to construct the lines, new access roads must be wider than normal forest roads, and existing roads generally have to be widened and upgraded considerably (Yeager 1973). In wet weather, all sites subjected to cross-country vehicle travel may sustain severe impacts, such as establishment of deep ruts and destruction of vegetation, which can result in accelerated erosion and possible nutrient loss.

EXISTING VEGETATION TYPES


1 Subalpine
2 Lodgepole Pine
3 Spruce – Fir
4 Western Larch
5 Douglas Fir
6 Western Ponderosa Pine
7 Eastern Ponderosa Pine
8 Ponderosa Pine Savanna
9 Limber Pine – Juniper
10 Juniper Complex
11 Cottonwood – Willow – Dogwood
12 Cottonwood – Willow
13 Boxelder – Green Ash – Rose – Chokecherry
Big Sagebrush – Bluebunch Wheatgrass
Big Sagebrush – Western Wheatgrass
Big Sagebrush – Western Wheatgrass – Grama
Big Sagebrush – Western Wheatgrass – Needle & Thread – Grama
Big Sagebrush – Grass
Silver Sagebrush – Grass
Silver Sagebrush – Greasewood
21 Alpine
22 Bluebunch Wheatgrass – Fescue
23 Bluebunch Wheatgrass – Needle & Thread
24 Western Wheatgrass – Needle & Thread – Green Needlegrass
25 Western Wheatgrass – Needle & Thread – Grama
26 Needle & Thread – Western Wheatgrass – Grama
27 Needle & Thread – Sand Dropseed
28 Grama – Needle & Thread
29 Badlands
Agricultural
No Data Available
● Near Pristine Vegetation
A-A' General Vegetation Profile
FLATHEAD
MISSOULA
GRANITE
MEAGHER
GOLDEN VALLEY
MUSSELSHELL
TREASURE
WHEATLAND
STILLWATER
BIG HORN
MADISON
BROADWATER
N
144 sq miles
36 sq miles
9 sq miles
4 sq miles
1 sq mile
42
36
30
24
12
0
12 miles

SOURCE: Melvin S. Morris, MSU Ag. Exp. Station, USFS, SCS

With the removal of vegetation from steep slopes with shallow soils, an increase in erosion potential will also occur, thus increasing the potential for nutrient loss. Runoff water from heavy rains can carry away the top layer of soil, including partially decomposed organic matter rich in nutrients. Nutrient loss can also occur on relatively level areas if cleared to mineral soil. Nutrients can be leached from the soil profile, out of reach of roofs, as a result of removal of duff material (buffer material) which acts to slow down water infiltration through the soil. Soil structure and texture also determine the rate at which water can move through the soil. Underground water systems can effectively move leached nutrients further from the area (Buckman and Brady 1969). With the reduction of available nutrients for plant growth, plants adjacent to disturbed areas could suffer a decrease in vigor and consequently be more susceptible to further damage.

Clearing of the survey line normally would not cause any adverse impacts. However, it is possible that a change in location of the line could be made, in which case there would be unnecessary damage to vegetation along the abandoned line. The impact of this damage could range from minimal to severe, depending of the extent of clearing. Also, trees and shrubs cut and left lying on the ground pose a risk of Ips beetle (Ips pini) and bark beetle infestation, which could spread to adjacent areas.

Along the right-of-way, vegetation cover must be cleared; all trees that would interfere with conductors or the installation of conductors and towers would be removed. Nutrient loss would not be as great as that caused by road construction, but would still be an important impact. Tower sites, staging areas, and concrete batch plant areas would be cleared and subjected to extensive equipment traffic. Tower sites, could possibly be cleared to bare mineral soil, especially on steep slopes. Heavy equipment concentrations in the other areas mentioned would also effectively remove vegetation down to bare mineral soil. In all areas where this occurs, nutrient losses can be significant.

The greatest impact on rangeland would be caused by the actual installation of the towers and conductors. The tendency for cross-country vehicle travel on rangeland is greater than on forest land because the lower-growing vegetation presents few barriers to such travel.

Riparian (stream bank) vegetation is very sensitive to disturbance. Right-of-way and access roads are certain to cross or parallel water courses at some point. Partial removal of riparian vegetation can have serious impacts on water quality and stream channel condition, and consequently on vegetation upstream and downstream from the disturbed site. Total removal of stream bank vegetation in the right-of-way is certain to cause these impacts because the stability of the bank would be lost. If this occurs over a large area or at a critical point along the stream, large portions of the stream bank could be dislodged, thus increasing the risk of flooding in spring and fall which could have a further detrimental effect on adjacent vegetation communities (Ryrgier et al. 1971).

2. Poisonous and Noxious Plants

In general, undesirable plants seldom invade a well-established native vegetation stand. The succession of plant species in disturbed areas depends on the available seed source and the ability of species to compete for existing moisture and nutrients. In areas where a seed source of undesirable plant species exists, extreme caution should be used in construction and maintenance practices to avoid disturbance of mature vegetation and exposure of mineral soil. Many noxious plants are highly competitive and readily move into disturbed sites. Since disturbed soils cannot be stabilized by a permanent cover in a short time (Morris & Meuchel 1956), sound construction and maintenance practices are required to prevent invasion by undesirable plants.

B. Operation Phase

1. Corona Effects

Corona discharge from electric transmission lines is known to result in electrochemical oxidants. The most significant are ozone (O_3) and nitric oxides (NO_x) (Zabrosky and Rittenhouse 1954, Scherer, Ware and Shih 1972). The amount of toxic gases produced is generally greater with higher voltage lines (500 KV to 765 KV). The threshold level for vegetation injury varies with species and even within species. The response or injury sustained by a given dosage also varies by stage of plant growth, nutrition, light intensity, relative humidity, and temperature. Measurements made under dual 500 KV lines at Oak Ridge, Tennessee, revealed ozone concentrations of 0.18 to 0.21 ppm (Auerbach et al. 1973). The exposure time for this test is not known. The background ambient ozone measurements have been subtracted from this and all other values reported. These abnormally high levels were attributed to moderate temperature inversions near mountains, which could also occur in Montana, especially in winter.

The synergistic effect of O_3 combined with sulfur dioxide (SO_2) produces injury to plants at lower concentration levels than the levels of either one acting alone. Tingey et al. (1973), however, indicate that O_3 concentration must be at least 0.05 ppm to produce synergistic effect with SO_2 for sensitive plants. Jaeger and Banfield (1970) documented synergistic effect at 0.05 ppm O_3 on eastern white pine (Pinus strobus) with SO_2 in 12 hours exposure.

The above studies indicate that a given concentration of ozone will cause damage to vegetation. Research is needed, especially in local areas, to determine what concentration levels will injure native and crop vegetation under various environmental conditions.

For example, it is conceivable in Montana that a synergistic effect of O_2 and SO_2 could occur in areas surrounding Billings, East Helena, Butte, Anaconda, and Missoula that have SO_2 in the atmosphere.

In the study area tree species most sensitive to ozone are ponderosa pine, boxelder, quaking aspen, and green ash (USFS 1973b). Sensitive crops include alfalfa, barley, oats, beans, rye, sweet corn, and wheat. Other sensitive vegetation includes snowberry and lilac (Hill et al. 1970).

Nitrogen dioxide (NO_2), one of the nitric oxides, acting alone will injure vegetation if concentration levels approach 2.5 ppm for four hours of sustained exposure (Taylor 1967). In another experiment, Taylor and MacLean (1970) found that very sensitive species, such as pinto bean and tomato, may be injured at 6 ppm of NO_2 for only a two-hour exposure.

In the study area only rye has intermediate toxic sensitivity to NO_2.

Although the above discussion has centered on known threshold concentrations of the two most significant toxic chemicals produced by transmission lines which cause visible vegetation injury, it is believed that photosynthetic activity and growth are adversely affected at lower levels (Treshaw 1965). For example, Darley and Middleton (1966) state that less than 1 ppm of NO_2 affects plant growth. A study by Miller, Parmeter, Flick and Martinez (1969) with ponderosa pine seedlings indicates that low concentrations of ozone also suppress growth.

C. Maintenance

To have the least constraint on transmission line operation and maintenance, vegetation on a transmission line right-of-way should be stabilized and low-growing. However, a plant community of this description is unlikely to develop if the original vegetation was stabilized, but not low-growing, such as a forest.

1. Revegetation

Since revegetation of right-of-way corridors to original vegetation communities is difficult and in some cases impossible, a monoculture (single species population) is often established. Without species diversity, wildlife habitat is reduced, and the vegetation could be subjected to species-specific insect infestations.

Revegetation should be restricted to native plant species whenever possible, since the use of introduced species can have impacts. Introduced species are often very hardy and able to adapt to a wide variety of ecological conditions. For this reason they are competitive with natural species and, in many instances, are capable of moving out of the right-of-way and replacing native vegetation.

2. Herbicides

When herbicides are used, they can affect vegetation outside the target areas. Drift of spray or volatile fumes via air currents and surface and underground watercourses can be definite hazards (Westlake and Gunther 1965). Rainfall can also act as an agent for transport of herbicides to areas remote from the site of application (Cohen and Pinkerton 1965).

3. Insecticides

In simplified or monotypic communities, the use of chemcial insecticides may be necessary to control insect outbreaks because natural predators do not usually occur in a monoculture (Kitchings et al. 1974). Insecticides can be transported from target to non-target terrestrial and aquatic communities (in the same ways that herbicides are transported).

11.1.5. Wildlife and Fisheries

11.1.5.1. Inventory

The transmission line study area includes a wide diversity of wildlife habitats, ranging from semi-arid steppe to coniferous forests and alpine tundra, and consequently harbors a wide diversity of wildlife species. Although much of this area is committed to land uses which are incompatible with wildlife, a relatively large proportion of the area is excellent wildlife habitat and allows a high productivity for many important species.

A. Game Mammals

Game mammals include elk, mule deer, white-tailed deer, pronghorn antelope, black bear, grizzly bear, bighorn sheep, moose, mountain lion, and mountain goat. The latter six species are primarily restricted to the mountainous regions of the western half of the study area.

Pronghorn antelope inhabit the eastern plains, while mule and white-tailed deer occur in suitable habitat throughout the study area. Elk herds are found primarily in and near the western mountains but also in the ponderosa pine forests north and east of Billings.

Elk and mule deer tend to be migratory, moving from high mountains to foothills and valley bottoms in winter. Pronghorn antelope also tend to concentrate in certain areas during the winter. These winter ranges are critical areas, and their extent and condition limit the number of individuals which can be maintained in the area.

B. Non-Game Species

Non-game mammals have not been studied or managed as intensively as game species; however, their role in the ecosystem is no less important.

Many furbearers occur along waterways, while most predators are found throughout the study area. Small mammals, found in nearly all habitats, are an important source of food for carnivorous birds, mammals, and reptiles.

C. Upland Game Birds

Nine species of upland game birds are found. Gray partridge, sharp-tailed grouse, and sage grouse occur in the eastern two-thirds of the study area. The latter two species winter in certain small critical areas and display during the breeding season on critical strutting or dancing grounds. Three species of mountain grouse occur throughout the mountainous portions; these are the blue grouse, ruffed grouse, and spruce grouse. Ring-necked pheasants are found primarily along river bottoms and in agricultural areas where grains are available as food. Merriam's turkey and chukar partridge occur in isolated patches primarily in the eastern two-thirds of the study area.

D. Waterfowl

Waterfowl include many species of ducks, geese, and swans; these are all migratory birds and are considered an international resource. Major lakes and rivers are important both as breeding and wintering areas for waterfowl. Important waterfowl migration corridors cross the study area, and during migration large flocks stop for food or rest in water areas along these flyways.

E. Endangered Species

The American peregrine falcon is the only endangered bird species known to occur regularly in the study area. The endangered black-footed ferret was once widespread on the plains of Central Montana, but no confirmed sightings have been made in Montana since 1953.

F. Fisheries

The study area encompasses some of the finest cold water fisheries in the country, including blue-ribbon trout streams. Important cold-water game fish include kokanee salmon, mountain whitefish, Dolly Varden, and cutthroat, brook, rainbow, and brown trout. The lower Yellowstone River supports an important warm water fishery, dominated by sauger, burbot and channel catfish.

11.5.2. Impacts

The construction, operation, and maintenance of overhead electric transmission lines affect all wildlife along the right-of-way; the nature and magnitude of these impacts vary from species to species. Several negative effects of transmission lines are well documented, and other probable effects are suspected. In certain cases, power lines may have positive effects on some species, and wildlife may also have a negative effect upon the transmission line itself.

Construction operations along the right-of-way involve the movement of men, equipment, and heavy machinery into areas of wildlife habitat, resulting in the temporary or permanent displacement of animals from the area. Vegetation damage and/or removal during construction may permanently destroy the habitat of certain species and prevent their return to the right-of-way. Construction noise may result in the abandonment of bird nests or of young mammals in the vicinity. Siltation of streams as a result of access road construction disturbs the aquatic ecosystem and limits the natural reproduction of trout.

There is little evidence to indicate that deer and elk normally avoid transmission lines once construction is completed, although in Scandinavia reindeer are deterred from crossing power line rights-of-way. The possible avoidance of transmission line corridors by deer and elk would have the greatest detrimental effect where the right-of-way separates summer and winter ranges. Some birds are reluctant to fly beneath power lines, and waterfowl hunter success has been known to decrease in marshes after power line installation.

The hum ("corona noise") produced by energized transmission lines may be a reason for avoidance of the lines by wildlife species. Birds nesting on towers may suffer damage to their auditory apparatus as a result of corona noise.

Several gases, toxic to living organisms, are produced in the air surrounding energized transmission lines. These gases, including ozone, nitrogen dioxide, free radicals, and singlet oxygen, are injurious to plants and irritating to animals at concentrations well below the lethal level. However, the concentration of these gases in the vicinity of energized transmission lines is probably negligible and has little or no significant effect upon wildlife.

Transmission lines are a cause of mortality in birds, especially nocturnal migrants. The number of birds killed is related to the height of the tower, and , although transmission line towers are not responsible for losses as great as those from taller structures (such as TV towers), they contribute significantly to the mortality of many species. In certain areas, most of the mortality of the Japanese sacred crane and 30% of the mortality of mute swans is attributable to wire strikes. Waterfowl are especially prone to wire strikes while approaching stopover areas and mountain passes during migration.

Low-voltage distribution lines are known to cause the electrocution of birds perching on the towers, especially eagles and other raptors. However, 500 KV transmission lines should not produce any bird electrocutions because of the greater distance between towers and conductors. Indiscriminate shooting of birds, especially raptors, from roadways near transmission lines can be a significant cause of mortality. It is thought that the magnetic fields around the conductors may interfere with the orientation and navigation of birds, although this has not been documented.

Transmission lines and towers may also have a positive effect on some species. The clearing of a transmission line corridor through a forested area may result in increased species diversity and abundance of birds and small mammals due to the edge effect. Shrubs growing in these clearings increase the amount of browse available for deer and elk. In areas where suitable trees and cliffs are unavailable, raptors, ravens, and magpies may build their nests on transmission line towers. However, these nests are subject to overheating by the sun and are frequently capsized by the wind.

Wildlife may also have a negative effect upon transmission lines. Flashovers caused by raptors defecating near an insulator string are a source of power outages, but this problem can be eliminated by proper design of the towers.

11.1.6. Meterology

11.1.6.1. Inventory

A. Climate

The climate in the study area varies significantly from its western to its eastern boundaries, due primarily to the Rocky Mountains. The mountains, which occupy approximately the western third of the study area, act as a barrier to low-level atmospheric flow.

West of the Continental Divide the mountains tend to maximize the importance of cool, moist Pacific air as a precipitation source, while reducing its importance for the plains area east of the Divide. The mountain barrier also tends to inhibit the penetration into the western regions of the air masses which enter the study area east of the Divide, including cold, dry polar air and warm, moist air from the Gulf of Mexico.

The climate of the western portions of the study area therefore reflects less continental characteristics than that of the eastern regions. Generally, west of the Divide the climate will include milder winters, cooler summers, a more even annual distribution of precipitation, higher humidity, more cloudiness in all seasons, and lighter winds that that of the eastern plains.

The climatic features most relevant to transmission line corridor selection are probably those parameters relating to line reliability (lightning incidence, tornado and other severe wind frequencies, and icing zones) and those weather effects relating to corona discharge (air density, humidity, and foul weather frequencies). Data with sufficient areal coverage and resolution to provide a basis for corridor selection are not available.

Climatic data will therefore not be considered explicitly in corridor selection. Climatic influences will be included implicitly in the evaluation of the corridor impacts on vegetation, erosion potential, wildlife habitat, and so on.

11.1.6.2. Impacts

A. Construction Impacts

1. Climatology

Construction of the transmission line will affect the local climate to the extent that existing vegetation cover is disturbed in access road and right-of-way preparation. The clearing of vegetation would result in higher wind speeds near the ground and a corresponding decrease in ground level humidity in the cleared area. The local radiation balance would also be altered due to increased insolation reaching the ground surface. Restoration of the previously existing vegetation would reverse these impacts, but such restoration may not always be possible because of maintenance considerations. No impact on regional or larger scale climate due to transmission line construction is anticipated.

2. Air Quality

Impacts on air quality would include an increase in dust levels, vehicular emissions, and emissions from open burning. Efforts should be made to minimize dust by sprinkling roads and construction areas and by retaining the vegetative ground cover wherever possible. No long term detrimental impact on air quality will result from transmission line construction.

B. Operation Impacts

1. Climatology

No impact on climate due to transmission line operation is anticipated.

2. Air Quality

Because the production of oxidants such as ozone and nitrogen oxide occurs during corona discharge, the transmission line would have some impact on air quality. Only limited information is currently available on which to base a prediction of the levels of oxidant production, and hence the magnitude of impact, of a 500 KV transmission line.

Three papers reporting on laboratory studies of corona discharge and oxidant emission rates from simulated transmission lines and two papers reporting on field studies of existing transmission lines, operating at voltages of 765 KV in one case and 345 KV and 765 KV in the other, appear to indicate that no significant impacts on air quality will result due to oxidant production in corona discharge with respect to existing air quality standards. The authors of one of the papers reviewed, Roach et al. (1973), stated, "Present experimental data is insufficient to establish reliable analytical predictions of the rates of corona produced effluents for transmission line conductors." Work published since the Roach et al. statement has apparently not altered this situation.

For this reason, and because studies to date do not indicate a significant impact of transmission lines on air quality, no attempt will be made to select transmission line corridors on the basis of ozone production rates.

11.2. Cultural Environment

11.2.1. Land Use

11.2.1.1. Inventory

Land use in the study area can be categorized into linear patterns, including transportation and utilities, and site patterns, including agricultural land uses, urban and residential land uses, industrial areas, water areas, woodlands, and specially managed areas. In addition to these existing land-use patterns, future land-use changes may make use of land use potentials and/or proposals.

A. Linear Patterns

The study area is traversed by many roads, ranging from interstate to gravel and primitive roads (see Land Use-Linear Patterns - Transportation Map). Existing roads are quite important in providing access to transmission line rights-of-way for construction and maintenance purposes. The major transportation corridor includes parts of Interstate Highways 90 and 94 and follows a general east-west route. Burlington Northern, Chicago-Milwaukee, and Union Pacific freight - railways serve the study area, and Amtrak offers east-west passenger service. The major airlines serving the study area are Northwest Orient, Western, and Frontier. Airports and landing - strips are scattered throughout. No major new transportation facilities are planned.

Numerous high-voltage transmission lines, 69 KV or higher in capacity cross the study area. The only 500 KV line runs southwestward from Hot Springs into Idaho. Gas pipelines and oil pipelines transport natural gas and oil from major fields in the study area. These utilities are shown on the land use Linear Patterns-Utilities Map.

B. Site Patterns

Land use site patterns in the study area, shown on the map of that title, are largely a function of physiography and of the availability and distribution of water. The amount of urban land use in the study area is small, and most urban land is concentrated in a few major cities. These centers of population growth are already well established, and it is unlikely that new urban centers will be created, although scattered built-up areas are increasing in rural settings. The major heavy industries in the study area are those associated with the mining of coal or metal ores and logging.

Irrigated lands are found almost exclusively along major river valleys and floodplains; dry cropland is found on upland benches primarily in the eastern two-thirds of the study area. The amount of irrigated land is increasing, and a more irrigated land is being used for hay production. Wheat, barley and oats are the major grain crops in the study area. Much land classed as potentially irrigable may never actually be irrigated due to the lack of available water in semi-arid regions. Rangeland in the study area supports an important livestock industry as well as many species of wildlife. Timber production is a dominant land use in the forested mountains of the western one-third of the study area.

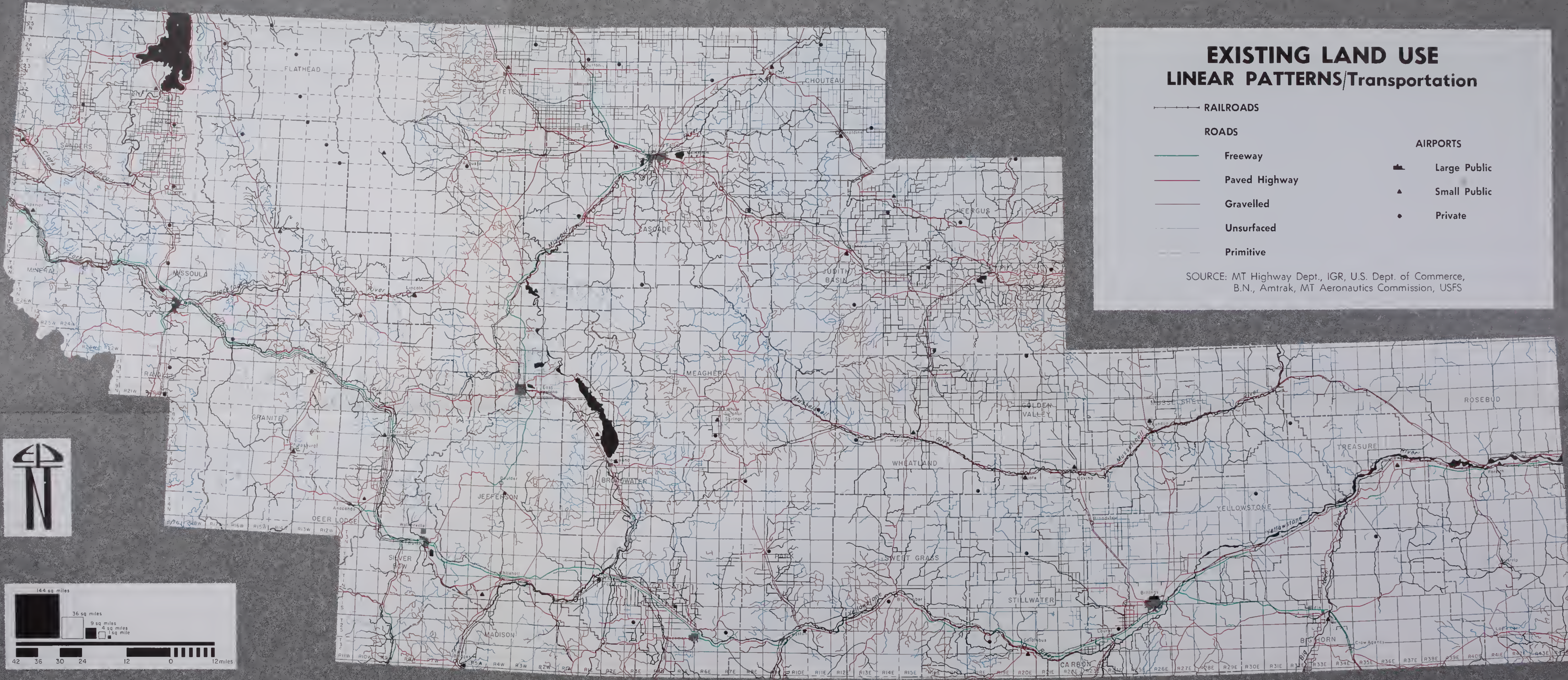
The study area includes wilderness areas, primitive areas, roadless areas which are under consideration for wilderness classification, - national wildlife refuges, game management areas, and potential wild and scenic rivers. These areas are under existing or proposed legal or administrative constraints against developments such as transmission line corridor routing. Snow survey stations and municipal watersheds are also managed to protect them from disturbances of timber, vegetative cover, and runoff associated with construction activities.

C. Land Ownership

Most of the forested land in the study area is administered by the U.S. Forest Service. Other land is owned by the U.S. Bureau of Land Management, the U.S. Bureau of Reclamation, the State of Montana, and private individuals and corporations, and includes parts of the Flathead, Crow, and Northern Cheyenne Indian Reservations.

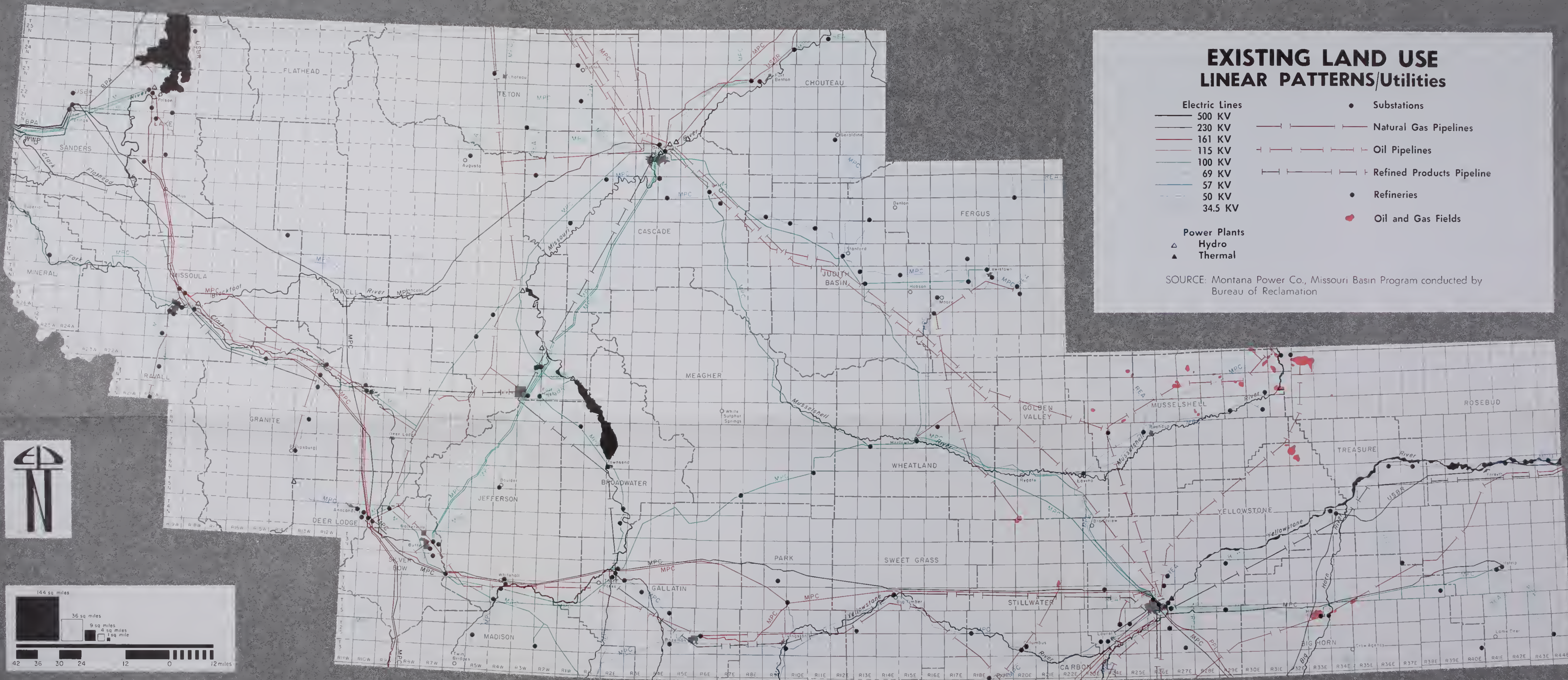
11.2.1.2. Impacts on Land Use

The severity of potential transmission line impacts on land use is cumulatively determined by the types of land uses involved, the tower locations, the construction technique used, the existing vegetative ground cover, the miles of access road generated, the corridor's aesthetic impact, and any resultant impacts on land uses of adjoining areas. The proposed line would be about 430 miles long and would require a 300-foot corridor, thereby directly affecting 15,636 acres and indirectly affecting an unknown number of adjacent acres. There are two general types of impacts which would result from the proposed line: physical and attitudinal. The former indicates interference with agricultural practice,



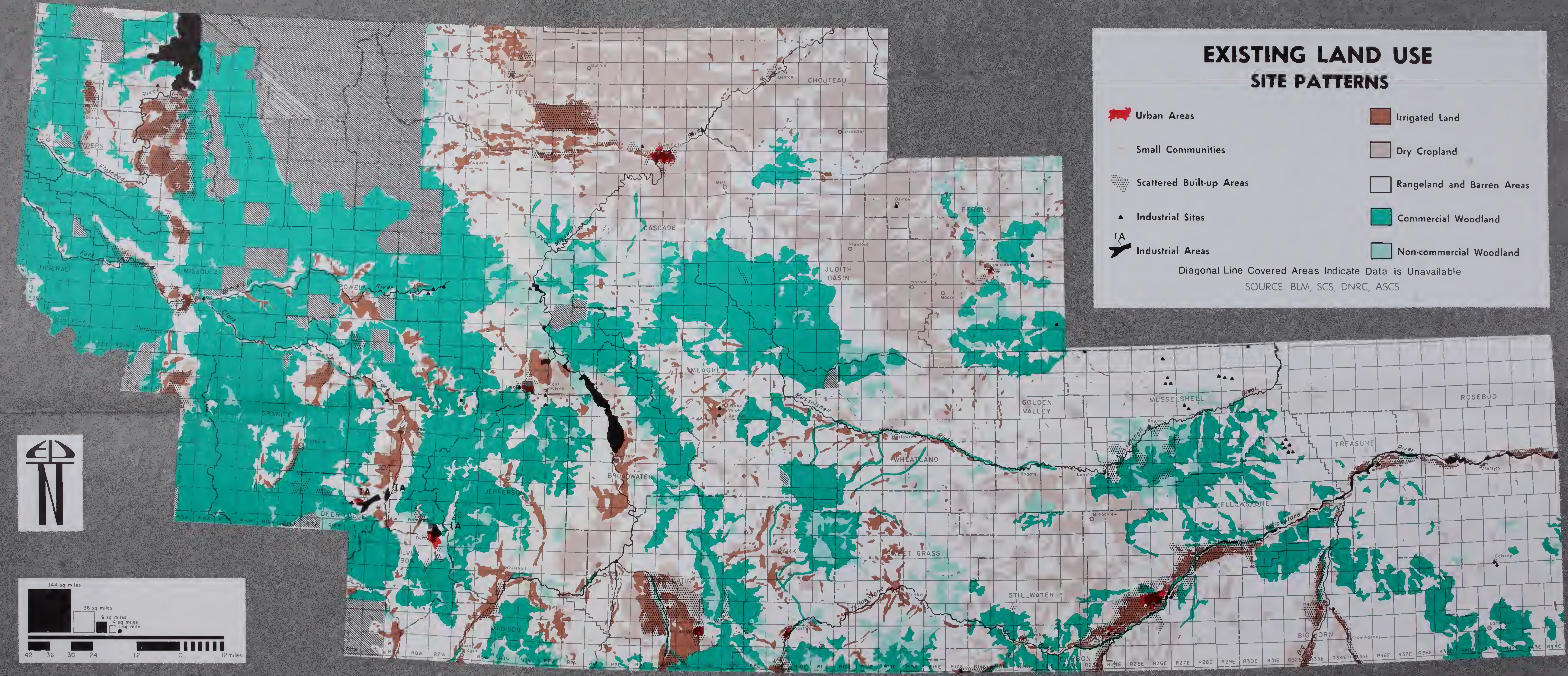
EXISTING LAND USE
LINEAR PATTERNS/Transportation

SOURCE: MT Highway Dept., IGR, U.S. Dept. of Commerce, B.N., Amtrak, MT Aeronautics Commission, USFS



EXISTING LAND USE
LINEAR PATTERNS/Utilities

SOURCE: Montana Power Co., Missouri Basin Program conducted by Bureau of Reclamation



EXISTING LAND USE

SITE PATTERNS

- 🟥 Urban Areas
- · Small Communities
- ▨ Scattered Built-up Areas
- ▲ Industrial Sites
- IA Industrial Areas
- 🟫 Irrigated Land
- ☐ Dry Cropland
- ☐ Rangeland and Barren Areas
- 🟩 Commercial Woodland
- ☐ Non-commercial Woodland

Diagonal Line Covered Areas Indicate Data is Unavailable

SOURCE: BLM, SCS, DNRC, ASCS

acres of potential erosion, etc.; the latter represents the impact of transmission lines on public opinion, and resultant sociologic behavior. Both types of impact are significant, but physical impacts are more easily quantifiable.

Impacts of transmission lines on agricultural land uses are determined by the specific locations of tower bases and guying cables, possible electrostatic and electromagnetic influences; access road locations, legal restrictions on land use beneath the lines, and construction activity. The location of the corridor on agricultural land may necessitate a change in agricultural practices currently in use on that land, such as aerial spraying techniques, contour plowing, and mechanical irrigation as an adjustment to tower height and foundations. Construction activity during the planting, growing, and harvesting seasons can severely limit the amount of productive land in the right-of-way. Range livestock patterns will also be disrupted when animals avoid construction areas (Hope 1974), which, depending on the location and time of year, can affect pasture and range rotation schedules.

Impacts of transmission lines on urban land uses include possible interference to communication systems, audible noise, site specific tower location interferences, and aesthetic influences; also, like any other linear land use pattern the line will define or divide urban spaces with possible potential sociologic implications.

Transmission line impacts could be terminal for certain valued areas, such as primitive areas, or could impose severe degradation on others, e.g. campgrounds. Recreation is an essential, stabilizing need for man and is manifested in Montana by numerous activities in a variety of landscapes. The need for recreation will grow as the population increase and leisure time expands. Montana's land expanses and recreational grounds serve a national user group now and will be more widely used in the future. Transmission lines can only detract from established recreational land areas and concentrated use points, and, accordingly, the recreational experience is diminished for present and future generations.

Two unique categories of recreation sites are archaeological and historical, with both serving important user groups. The known areas serve as societal links to the past, and physical disturbance from construction equipment could eradicate the subtle relationship of artifacts that professionals use to understand and date a specific site. Known sites should be protected, and newly discovered sites should be avoided or at least scientifically investigated and evaluated before being disturbed.

The reduction in beauty of a landscape caused by the presence of a transmission line can be observed, but the impact of that reduction of beauty can only be felt. For some, a reduction in the beauty of a significant landscape would constitute a significant reduction in the quality of life.

Transmission lines are not an improvement on most landscapes, but if the alignment and corridor design are aesthetically oriented rather than strictly economically oriented, the aesthetic impacts can be lessened.

The number of people who view a transmision line is also not a true quantitative indicator of aesthetic impact. Section 70-802 of the Montana Utility Siting Act addresses its purpose to future generations. Therefore, an estimate of visual impact of transmission lines should include a concern for population growth and future visual impact.

One reason that the current-number-of-viewers theory could be rendered invalid is based on the concept of expectancy. More people would see the line if it were routed near an urban area, but the viewers' expectation of scenic beauty would not be as high in such an area. Visitors at a state park would probably have expectations of scenic beauty; under these circumstances, the impact of encountering a major transmission line would be magnified. The same is true of most recreation areas, including historic sites, national forests, and urban parks. The number of users of these areas does not accurately reflect the potential aesthetic impact of a transmission line on those areas.

Proposed and potential land uses would be altered as present land uses are affected by a transmission line corridor. The lines' existence would become another determinant for land use. If the lines prove to be a severe handicap to existing land uses, plans for future land uses can also be expected to change.

The land uses specifically discussed represent only a segment of the many ways land is used, and impacts can range from neutral on city dumps to severe on certain types of agricultural and recreational lands. This same range would be indicative of the impacts on land uses not specifically mentioned.

11.2.2. Social and Economic Factors

11.2.2.1. Population

A. Inventory

The transmission line study area includes all or portions of 34 Montana counties. The county populations range in size from 675 inhabitants in Petroleum County (population density=0.4 persons per square mile) to 87,367 people in Yellowstone County (density=33.1 persons per - square mile).

Population distribution varies significantly. The major concentrations of people (as illustrated by city size and population density) tend to be in the valley bottoms of the Yellowstone, Gallatin, Clarks Fork, and Missouri Rivers in the southern and western portions of the study area. Great Falls and Lewistown are the most conspicuous exceptions to the pattern with locations in the north-central portion of the state.

Population size and density is lowest in the northeastern and highest in the north and southwestern quadrants of the study area. Small communtiies from 100 to 2,500 people which function as commercial and service centers for the surrounding agricultural population are distributed throughout the study area.

B. Impacts

The impacts of the proposed transmission lines from Colstrip to Hot Springs can be separated into impacts associated with the construction phase and long-term impacts associated with the lines' presence and operation.

Population increases can be expected to have the greatest impact during the construction phase when construction personnel migrate into areas where the lines are to be built. The Westinghouse report (1973) projects that 300 construction personnel will be needed to build line segments approximately 110 miles in length.1/ Six months of construction time is projected to build each line segment.2/

Completion of one segment will be followed with initiation of construction on another. It is anticipated that construction crews will move with the construction project. During the construction phase, construction manpower will be organized into crews ranging in size from 3 to 4 men up to 25 to 30 men scattered along the line segment doing such tasks as right-of-way clearance, tower erection, conductor stringing, etc.

While construction crews may work scattered along the length of a line segment, their probable place of residence would be in the small communities near the transmission corridor. The estimated maximum population increase per line segment is 675 persons. This estimate assumes that all 300 construction personnel would be in-migrants and that 50% of the workers would be accompanied by 2.5 dependents each. If construction crew size is less than 300 persons or if part of the construction crews are hired locally, population influx would diminish accordingly.

Construction-related population increases will probably be distributed along the length of the line segment. The actual influx into a given area is incalculable since it will depend on a host of factors including proximity to the construction site, available housing, social and recreational services, etc.

Completion of the construction phase will be followed by small population increases where substation operations or maintenance crews are based. No estimates are available as to how many personnel will be needed for these tasks.

11.2.2.2. Social Organization

A. Inventory

The existing pattern of land use, primarily agricultural and forested properties, reflect the pattern of social organization throughout most of the study area. Populations are small and widely distributed on ranches, farms, or in small towns. Social organization is typically "gemeinschaft," that is, social relationships are deeply personal and based upon long familiarity with persons sharing a similar life style and set of life circumstances. Integration into social "communities" is usually a slow, gradual process, and it is common for individuals to be classified as "newcomers" or "outsiders" even after living in an area for a number of years.

B. Impacts

The impact of the construction of the 500 KV lines on established patterns of social organization is expected to be minimal. The presence of migrant construction workers and their families will not appreciably alter the existing patterns of social organization. The local business community can expect some increase in demand for its goods and services. Some social disorganization, particularly in the form of rowdy behavior and fighting, may also be expected, especially in local taverns where construction personnel may congregate. Trespassing on private property may also be expected as construction crews move equipment to job sites, travel to work, or seek outdoor recreational activities such as hunting, fishing, picnicking, etc.

The largest group of impacts associated with construction activites are property damage and inconveniences to landowners whose property is crossed by the transmission line right-of-way. Property damage to crops, fences, gates, and agricultural land often occurs when construction crews stray off the right-of-way or access roads with private vehicles and construction equipment.

Long range impacts associated with the lines' presence and operation include the following:

1) Tower structures take cropland out of production. This problem is exacerbated if more than one line is located on the right-of-way or if the towers are staggered rather than placed parallel to one another.

2) Maintenance personnel create nuisances and inconveniences similar to those caused by construction crews by moving equipment through cropland, damaging fences and gates, and failing to remove debris.

3) Corona effects and audible noise are nuisance impacts. The quality of television and radio reception declines

while audible noise increases.

4) An aesthetic impact exists as the lines are often viewed as damaging the scenery.

11.2.2.3. State-Wide Public Opinion Survey

The state-wide public opinion survey conducted by the Department in August 1974 is briefly explained in Section 8.2.2.c. An analysis of survey results concerning Units 3 and 4 and associated development is also presented there. The following paragraphs contain an analysis of opinions concerning transmission lines.

Respondents indicated a general pattern of opposition to high voltage transmission lines (See Table 11-4). An item asking if respondents favored the construction of high voltage transmision lines in Montana met with 40.3% disapproval, 36.3% approval, and 22.2% taking a neutral position. A clear majority of respondents (59.6%) indicated that they preferred to live in an area without the presence of high voltage transmission facilities. Respondents indicated consistency in this regard, with a 62.7% rate of disapproval of the idea of having high voltage lines located on their personal property. A slightly smaller percentage objected to having lines built even if such facilities were not located on their personal property (57.9%).

Using existing transmission corridors for future transmission line construction was strongly supported by respondents. However, the idea of building power lines in relatively uninhabited areas of the state was only modestly supported (45.1%). Almost 34% disapproved of the idea, with 19.4% holding a neutral position. Respondents generally approved of transmission line construction provided the lines were for the specific use of Montanans (49.6%). An item suggesting that power companies pay an annual fee to landowners whose property is crossed by transmission facilities was met with strong approval (72.6%).

In summary, the respondents are generally opposed to the construction of high voltage transmission lines. They prefer to live in areas without the presence of the lines and do not want such facilities on their personal property. Existing corridors are the preferred location for future line construction, especially if the corridor is in a relatively uninhabited area. However, the idea of running transmission corridors through relatively uninhabited, virgin territory is met with only modest approval. Finally, there is strong sentiment for the idea that power companies pay annual fees for transmission line right-of-way.

11.2.2.4. Social Services

Social services vary significantly throughout the study area. With increasing population there is a tendency for a community to possess a

TABLE 11-4

TRANSMISSION LINE
PUBLIC OPINION SURVEY RESULTS

I favor the construction of high voltage electric transmission lines within Montana.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
7.3%	29.0%	22.2%	18.1%	22.2%
No Response 1.2%		Total N[1] = 775		

I would prefer to live in an area without the presence of high voltage electric transmission lines.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
32.0%	27.6%	24.3%	11.7%	3.4%
No Response 1.0%		Total N = 777		

I would have no objection to the presence of a high voltage electric transmission line on my property.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1.9%	17.0%	16.3%	25.3%	37.4%
No Response 2.1%		Total N = 423		

Provided high voltage electric transmission lines are not located on my property, I have no objection to having them built elsewhere.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
0.9%	12.3%	26.5%	35.9%	22.0%
No Response 2.4%		Total N = 423		

[1] N = Total number responding

TABLE 11-4 (cont.)

High voltage electric transmission lines should be constructed in areas where power lines currently exist.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
11.1%	48.5%	22.5%	12.3%	4.0%

No Response 1.7%
Total N[1] = 423

High voltage electric transmission lines should be built in relatively uninhabited areas of the state.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
9.2%	35.9%	19.4%	23.2%	10.4%

No Response 1.9%
Total N = 423

High voltage electric transmission lines should only be constructed if they are designed to specifically serve Montana residents.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
14.4%	35.2%	17.3%	26.7%	4.7%

No Response 1.7%
Total N = 423

Power companies should pay an annual fee to property owners whose lands are crossed by electric transmission lines.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
27.7%	44.9%	17.3%	7.6%	1.7%

No Response 0.9%
Total N = 423

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[1] N = Total number responding

larger and more comprehensive system of social services. The larger municipalities contain city, state, and federal social service agencies of all types.

Since much of the study area is dominated by patterns of rural settlement and social organization, social services are relatively underdeveloped in significant portions of the study area. Social services (e.g. law enforcement, welfare services, and fire protection) are primarily provided by county governments. Health care is provided by private practitioners, with health care facilities predominantly provided by county or city-county governments. The county seat is the operational location of locally provided social services.

Housing is generally in short supply - throughout the study area, although the larger cities contain more housing opportunities than do rural areas. Population decline and a slowing birthrate have contributed to a general state of excess capacity in school facilities, particularly in rural areas where outmigration has been substantial.

B. Impacts

The impact of the transmission facility on social services is contingent upon population influx and distribution. The small and transient nature of the construction crews and their expected dispersal along the transmission corridor segments suggest that existing social serivce delivery systems should be adequate to deal with the expected population influx in most instances. The work load of certain social services such as police protection may be expected to increase by some degree, but unless the service delivery systems of a community or county are already deficient, the additional population should not require added services or service personnel. Also, the transient nature of the population influx discourages improving social service delivery systems, as do the budgeting constraints of social service agencies.

The greatest social service impact may be expected in relation to housing and educational services. Housing is generally unavailable in the study area. In rural areas where municipal services such as water and sanitation are underdeveloped, it may be difficult to significantly add either permanent or temporary housing. The use of mobile homes and trailers can be expected to help offset shortages of permanent housing where the latter is not locally available. Declining population in many of the counties has contributed to a general excess capacity in school facilities, although additional teachers may be necessary.

11.2.2.5. Economic Factors

A. Inventory

The study area runs from southeast Montana to the northwestern part of the state and includes a variety of landscapes and economic activity. The four major industrial centers of the state, Billings, Butte, Great Falls and Missoula all lie within the boundaries of the study area. The study area includes extensive agricultural acreage in the east and a large segment of the states' timber industry in the west. The general patterns of land use are more thoroughly described in Section 11.2.1.

Construction of large sections of the proposed transmission lines would necessarily be carried on far from any area trade centers. In such cases the local area would not be in a position to "capture" the potential markets represented by the well-paid construction crews. Most of the secondary economic effects would be gained by the few large trade centers of the region (Helena, Billings, Missoula, Butte, Great Falls, and Bozeman, depending upon the route).

Much of the economic impact of the transmission line will depend on the primary employment the line construction provides. Whether or not these jobs go to Montanans or to out-of-state labor depends heavily on the availability of in-state skills. Labor for right-of-way clearing should be available within the state. The International Brotherhood of Electrical Workers (IBEW) in Billings reported generally full employment conditions among their members in Montana as of mid-1973 (Westinghouse 1973). In a survey conducted in October 1974, Local 532 reported thirty job openings for electricians at Colstrip with no locally available electricians. It is on the basis of this labor supply situation that the majority of the line construction crews are expected to come from outside Montana.

B. Impacts

The impact of the construction and operation of the two 500 KV lines from Colstrip to Hot Springs on local economic activity is difficult to assess for individual localities through which the lines might be built. For this reason the impacts are viewed in terms of the whole line and the entire state.

A number of possible economic impacts would be caused by the construction and operation of the proposed transmission lines. On the positive side there is the direct and secondary employment and income generated during the construction phase. Once built, the lines would provide a substantial source of tax revenue for those counties crossed by the lines.

On the negative side, construction activity and the physical presence of the towers limits the use of the land crossed. This is aggravated by the high percentage of guyed towers proposed. For typical guyed towers in level terrain, the four tower guy anchors form a square, 118' on each side (Westinghouse 1973).

The direct impact of the construction activity on the Montana economy would be due mostly to the local spending done by the influx of well-paid labor. It is expected that most of the labor would be from out of state, and most of the materials, likewise, would be imported. Some material (e.g. concrete) and some labor (e.g. clearing crews) would probably originate locally.

In order to estimate the impact of the construction of the lines on the local economy, a number of underlying parameters must be estimated. Assuming the materials used are not indigenous, labor input becomes the most important variable. Labor inputs themselves have to be broken down further if there are groupings which can be expected to exhibit different spending behavior. In addition, some assumptions about the local economy have to be made with respect to imported versus locally produced goods and services.

The labor input estimated here comes from multiple sources. Three estimates of total transmission line construction costs were made in Chapter 4. The middle estimate of $161,389,248 for the total costs of the two lines is used here. This figure is in mid-1974 dollars. In the applicants' analysis (Westinghouse 1973), construction costs of $85,444,000 were estimated. There is little detail provided as to what is and is not included in this figure; however, labor is estimated at 30% of the total. Since this estimate, inflation has increased the dollar costs greatly. Although the greatest increase has been in material prices, labor costs have also increased. The 30% share of costs allocated to labor is used here, yielding a total labor cost of $48,416,774.

In addition to the line construction costs of building the two lines from Colstrip to Hot Springs, there is also the cost of the associated substations at Colstrip, Broadview, Helena and Hot Springs. The substation costs are estimated at $35,073,000 of which 15% or $5,260,950 is estimated to be labor costs (Westinghouse 1973).

Combining the labor estimates, total labor cost is estimated to be $53,677,724. Take home pay would be much less than this, since this figure includes state and federal income taxes and fringe benefits. Assuming the employer's contribution to Social Security and other fringe benefits to be equal to 10% of the total labor cost, gross wages would then be $48,718,953.

Assuming gross income per worker at $15,000 per year, take home pay would range from about $10,883 for a worker with no dependents upward, depending on the number of dependents claimed. If it is assumed that the typical worker claims two dependents in addition to himself, he will pay about $1,985 in Federal income tax, $600 in state income tax and $772 in Social Security contributions. These tax figures are based on 1973 tax forms; the Social Security payment is based on 1974 figures.

Based on this split of the $48,718,953 gross wages, federal income taxes will account for $6,447,141, Social Security payments will amount to $2,507,402, state income tax will take an additional $1,948,758 and the remaining $37,815,652 will be the approximate take home pay (less any employee contributions to health insurance, retirement, etc.).

In order to calculate the secondary income created by the primary construction employment, additional information is needed on local spending behavior and the percentages of purchases that are spent on local and imported goods and services. The assumptions made in the applicants' analysis (Westinghouse 1973) are used here. These assumptions are as follows:

1) The labor force is made up of 20% state residents and 80% from out of state.

2) Of the 80% nonresidents, 40% will bring their families with them.

3) Those accompanied by families (the 20% residents and the 40% of the 80% nonresidents) will spend 70% of their budgets locally, and those without families will spend 35% of their budget locally.

4) Of the total local expenditures, 40% will be for locally derived goods and services.

From these assumptions a kind of local income multiplier can be calculated. Assume the local merchants exhibit the same spending behavior as the nonresidents with families and the resident line workers (3 above). This will yield for each dollar of take home construction pay to residents or non-residents with families, an additional .389 dollars of local secondary income. The multiplier for non-residents without families will be half as large or .194. These multipliers do not take into consideration taxes and social security contributions beyond the construction workers. The effect can be expected to be minimal.

The results of these assumptions are shown in Table 11-5. Secondary income is $11,170,745, and if added to primary gross pay (before taxes) would yield a total income impact of $59,880,698. Of this total, $20,914,536 ($9,743,791 for resident construction workers and $11,170,745 in secondary income generation) would be income to the local population and $38,975,162 would be paid to nonresidents.

State income taxes flowing from the construction payroll would be about $1,950,000. This figure is based on the typical worker earning $15,000 per year and having two dependents in

TABLE 11-5

DETERMINATION OF LOCAL INCOME IMPACT

Labor Category	Take Home Pay	Secondary Multiplier	Secondary Local Income Generated
Resident	$ 7,563,130	.389	$ 2,942,058
Nonresident with Family	12,101,009	.389	4,707,293
Nonresident without Family	18,151,513	.194	3,521,394
Total	$ 37,815,652		$ 11,170,745
		Plus gross primary wages	48,718,953
		Total impact on income	59,889,698
		Less income to nonresidents	38,975,162
		Total income to residents	$ 20,914,536

addition to himself. State income taxes derived from secondary income would be much less for two reasons. First, the absolute size of secondary income is much smaller and second, the percentage of income paid in taxes would be smaller because the wages per worker would be substantially smaller (the Montana income tax rates are progressive, i.e., they increase as the income itself increases).

The other large positive impact of the transmission lines would be the increase in property taxes that would come from the lines. In order to estimate the property taxes that would be paid on the transmission lines, a number of simplifying assumptions must first be made.

In Montana, all of an electric utility company's property is taxed as a single unit, and it is very difficult to estimate what the contribution of any single piece of the total plant is to the total company assessment. An additional complication in this case is that the lines may be owned by five separate companies,

In evaluating the total property of a utility, three things are considered. These are: 1) the current price of the company stock, 2) current earnings of the company and 3) actual cost of plant equipment the company owns. In order to estimate property taxes on the lines alone, it is assumed here that the contribution of the lines and the substations to total property assessment is their original cost: $196,462,248. This figure is then multiplied by a .40 equalization factor and again by .40 (Class 9 utility property) to yield an equalized taxable value of $31,43,960. In reality this figure would be prorated between the various counties in which the lines were located. Individual county mill rates would then be levied on each counties share of the $31,433,960. This procedure has been bypassed here and the average 1974 mill levy for all counties has been used. This levy is 210 mills and yields an estimated annual property tax on the lines of $6,601,132.

11.3. Impacts of Alternate Corridors

The corridor selection process attempts to align utility corridors in such a manner as to minimize adverse environmental impacts and interference with land uses, while at the same time allowing for maximum system reliability and proximity to load centers. One important consideration in the evaluation of alternate routes is the amount and type of land use which would be affected by the construction and physical presence of the utility structure. Certain types of land use, such as urban areas and irrigated lands, may be more incompatible with high-voltage transmission lines than other types, such as rangeland. This section presents a tabular comparison of land uses along each of several possible routes for the proposed Colstrip-Hot Springs twin 500 KV transmission lines.

The accompanying Alternative Corridors map overlay located at the back of this volume shows the location of the MPC preferred route for the proposed transmission line, alternative MPC corridors, and several preliminary Energy Planning Division (EPD) corridors. The EPD corridors shown are not necessarily those which will be recommended by the EPD in the final environmental impact statement; the final recommendation will be based upon further analysis of environmental impacts and upon public comment (See Section 12.5.).

In Table 11-6 the approximate number of square miles of several types of land use which would be crossed by the two-mile wide corridor segments is listed for each corridor segment shown on the map. These figures are based on the land use inventory maps prepared for this study. Much detail, including many isolated areas less than 160 acres in size, was lost during the process of reducing the rough maps (prepared at a scale of 1"=2 miles) to the working maps (which were at a scale of 1"=12 miles). Therefore, in this general comparison, areas were estimated only to the nearest square mile.

It should be realized that the figures given are for a two-mile wide corridor, while the actual corridor right-of-way is a width of 300 feet. The centerline of the 300-foot corridor will be located within the final two-mile corridor so as to minimize negative impacts and interference with land uses. Thus, for a corridor segment which includes several square miles of dry cropland, for example, proper centerline selection may in some cases reduce the actual amount of dry cropland affected to nearly zero.

TABLE 11-6

Comparison of Alternate Corridor Segments

Segment	Length (mi.)	Area (sq.mi.)	Land Use Categories Affected (sq. mi.)[1]						
			Urban	Small Communities	Irrigated Land	Dry Cropland	Woodland[2]	Range-land	Scattered Built-up Areas
A-1	72.5	145	0	0	4	4	97	40	0
A-2	39.0	78	0	0	1	0	69	8	3
A-3	24.0	48	0	0	6	3	7	32	3
A-4	13.5	27	0	0	0	1	7	19	0
A-5	46.5	93	0	0	16	1	8	68	3
A-6	67.0	134	0	0	48	20	5	61	16
A-7	68.0	136	0	Tr[3]	22	20	6	88	30
A-8	60.5	121	0	0	8	4	21	88	5
A-9	40.0	80	0	0	0	11	11	58	0
A-10	27.5	55	0	0	0	32	2	21	14
A-11	44.0	88	0	0	12	15	12	49	3
A-12	22.5	45	0	0	4	4	11	26	5
A-13	77.5	155	0	0	4	14	33	104	5

TABLE 11-6

Comparison of Alternate Corridor Segments

			Land Use Categories Affected (sq. mi.)[1]						
Segment	Length (mi.)	Area (sq.mi.)	Urban	Small Communities	Irrigated Land	Dry Cropland	Woodland[2]	Range-land	Scattered Built-up Areas
B-1*	15.5	31	0	0	5	3	0	23	4
B-2	18.0	36	0	0	7	2	1	26	2
B-3	19.5	39	0	0	11	0	3	25	6
B-4	52.5	105	0	0	7	0	88	10	0
B-5	10.5	21	0	0	1	0	4	16	0
B-6	9.5	19	0	0	2	0	1	16	0
B-7	8.5	17	0	0	1	0	0	16	1
B-8	13.0	26	0	0	0	0	15	11	8
B-9	27.0	54	0	0	12	2	14	26	0
B-10	6.5	13	0	0	1	0	1	11	0
B-11	3.5	7	0	0	0	0	6	1	0
B-12	8.5	17	0	0	2	0	11	4	0
B-13	8.0	16	0	0	3	0	8	5	0
B-14*	9.5	19	0	0	0	0	2	17	0
B-15	14.0	28	0	0	0	0	27	1	0
B-16	9.5	19	0	0	0	0	17	2	1
B-17	42.0	84	0	0	11	3	30	40	0
B-18	13.0	26	0	0	0	0	19	7	0
B-19	8.5	17	0	0	0	0	6	11	0
B-20*	40.5	81	0	0	6	6	14	55	0
B-21	35.0	70	0	0	13	4	8	45	0
B-22*	27.0	54	0	0	5	4	17	28	0
B-23	18.0	36	0	0	3	2	17	14	0
B-24	56.0	112	0	0	0	22	14	76	0
B-25	20.5	41	0	0	0	3	10	28	0
B-26	14.5	29	0	0	7	14	0	8	0

TABLE 11-6

Comparison of Alternate Corridor Segments

			Land Use Categories Affected (sq. mi.)[1]						
Segment	Length (mi.)	Area (sq.mi.)	Urban	Small Communities	Irrigated Land	Dry Cropland	Woodland[2]	Range-land	Scattered Built-up Areas
B-27	32.0	64	0	0	8	0	26	30	0
B-28	48.5	97	0	0	0	25	7	65	0
B-29*	25.0	50	0	0	0	15	5	30	0
B-30	10.0	20	0	0	0	0	0	20	0
B-31*	21.0	42	0	0	0	3	7	32	0
B-32	78.5	157	0	0	4	3	15	135	0
B-33*	63.5	127	0	0	1	4	33	89	0

TABLE 11-6

Comparison of Alternate Corridor Segments

			Land Use Categories Affected (sq. mi.)[1]						
Segment	Length (mi.)	Area (sq.mi.)	Urban	Small Communities	Irrigated Land	Dry Cropland	Woodland[2]	Range-land	Scattered Built-up Areas
C-1	12.5	25	0	0	6	4	2	13	0
C-2	9.0	18	0	0	9	0	0	9	0
C-3*	23.5	47	0	0	5	0	27	15	0
C-4*	14.5	29	0	0	0	0	27	2	0
C-5	15.0	30	0	0	14	0	2	14	1
C-6	5.5	11	0	0	0	0	9	2	0
C-7	19.5	39	0	0	0	0	33	6	0
C-8	104.5	209	0	1	33	5	25	144	0
C-9	56.0	112	0	0	5	1	53	53	0
C-10*	26.5	53	0	0	1	7	0	45	Tr
C-11	29.0	58	0	0	3	6	3	46	0
C-12*	76.0	152	0	0	8	35	29	80	0

TABLE 11-6

Comparison of Alternate Corridor Segments

			Land Use Categories Affected (sq. mi.)[1]						
Segment	Length (mi.)	Area (sq.mi.)	Urban	Small Communities	Irrigated Land	Dry Cropland	Woodland[2]	Range-Land	Scattered Built-up Areas
D-1*	21.0	42	0	Tr	29	0	0	13	20
D-2	7.9	15	0	0	1	1	1	12	2
D-3*	10.5	21	0	0	0	0	20	1	4
D-4*	39.0	78	0	0	9	2	55	12	0
D-5*	10.5	21	0	0	4	3	2	12	0
D-6	21.0	42	0	0	2	1	29	10	0
D-7	13.0	26	0	0	2	0	19	5	0
D-8	32.0	64	0	0	0	0	40	24	0
D-9	36.0	72	0	0	4	0	42	26	0
D-10	49.5	99	0	0	2	23	10	64	0
D-11	54.0	108	0	0	3	4	33	68	0
D-12	84.5	169	1	0	5	73	1	89	8
D-13	21.5	43	0	0	0	7	1	35	0
D-14	83.0	166	0	0	2	70	0	94	0
D-15	32.0	64	0	0	5	34	1	24	0

[1] All categories are mutually exclusive except for scattered built-up areas.
[2] Includes commercial and noncommercial woodland.
[3] Tr= trace

* MPC preferred route.

11.4. Recommended Procedures to Minimize Impacts

11.4.1. Construction

11.4.1.1. Survey

1) Restrict cross country travel, especially on croplands and fragile soils.

2) Minimize clearing and keep it within areas to be cleared later.

3) Use helicopters and existing roads to the maximum extent possible.

4) Minimize flagging, aerial survey targets, and other similar materials. Insure they are removed before final project completion.

5) Assign state and federal environmental control inspectors to project while in this phase. Thses inspectors can watch for compliance with the above guidelines. They can also influence tower and centerline locations of transmission lines and roads. Such changes are more easily made during this state. These inspectors should remain until the project is completed.

6) Design for minimum roads, clearing, special sites, etc.

11.4.1.2. Clearing

1) Clear to minimum requirements rather than maximum.

2) Comply with the Environmental Criteria for Electric Transmission Systems issued by U.S. Departments of the Interior and Agriculture. These criteria are broad enough to be applied throughout the line length.

3) Combine special sites such as reel sites, staging areas, tower sites, and roadways to the maximum extent possible.

4) Sell all merchantable timber and dispose of slash by complete burning in air-curtain burners or other aesthetic approaches, such as chipping, burying for removal.

5) Limit cross country equipment travel.

6) Plan construction to avoid needless or repeated clearing.

7) Try to avoid narrow ridgetops and steep slopes for tower sites, especially angle or dead end towers.

8) Use the smallest equipment that will do the job.

9) Cut stumps to within three inches of the highest ground.

10) Leave all low-growing vegetation except where essential for complete removal such as at footing locations.

11) Where possible, horses, hand methods, or small power tools should be used for clearing.

12) If heavy equipment is used, some removal of topsoil will be unavoidable. Therefore topsoil removed during construction should be stockpiled and replaced after construction.

13) Long tunnel views of transmission lines crossing highways in wooded areas, down canyons and valleys or up ridges and hills should be avoided. This can be accomplished by having the lines change alignment in making the crossing, or in other situations by concealment of terrain or by judicious use of screen planting.

14) In clearing and construction operations, avoid contact with stabilized talus slopes and other prominent rock exposures. Talus slopes become unstable if disturbed and even slight disturbances in lichen-covered rock can leave a highly visible scar.

11.4.1.3. Road Construction

1) Use state highway and U.S. Forest Service road design and construction criteria for permanent roads. Use minimum standards required for the type and use of road. Temporary roads should also be designed to prevent erosion.

2) Design for the traffic and equipment to be used, single lane.

3) Try and combine permanent roads with other transportation plans such as county or federal agency needs.

4) Minimize all roads.

5) Install proper drainage and base material.

6) Avoid encroachments near rivers or live streams. When crossing, use bridges or culverts.

7) Trees, shrubs and grass not cleared should be protected from damage during construction.

8) Terraces and other erosion control devices should be constructed where necessary to prevent soil erosion on slopes on which rights-of-way are located without undue delay.

9) Where rights-of-way cross streams or other bodies of water, the banks should be reclaimed and stabilized to prevent erosion.

10) Top soil should be stockpiled and spread on road cuts prior to reseeding.

11) Road locations should be to one side of right-of-way, enabling traffic to avoid cables and conductors during the wire stringing operation. Necessary crossings of right-of-way centerline should be near towers for the same reason.

12) Specifications for gates, cattle guards and bridges should be included in the road construction contract.

13) Avoid off-road travel by vehicles.

14) Construct temporary roads on the levelest terrain, even if this requires significant departures from the right-of-way, and especially if the total amount of excavation is reduced.

11.4.1.4. Tower Erection

1) Utilize helicopters to the maximum possible.

2) Use the smallest ground equipment that will do the job.

3) Carry out crane pad construction with the crane crew—not the clearing crew. Do not construct crane pads on level ground.

4) Require hand excavation in highly sensitive or fragile areas.

5) Install guy anchors and counterpoise equipment carefully to restrict disturbances to a small area.

6) Concrete batch plant sites are areas of high use; therefore, provisions for sanitary facilities and waste disposal should be made at each of these sites. Also, sites should be chosen that have adequate water supplies.

7) Tower sites should be chosen to minimize disturbance of agricultural land.

11.4.1.5. Conductor Stringing

1) Lift tower electrical hardware by pulling with winch rather than cross-country vehicle.

2) Fly in sockline by helicopter.

3) Insure all guard structures are installed including protection to small items such as fences prior to sockline pulling.

4) Make sure clean up is thorough and proper to avoid animal "hardware" poisoning or injury.

5) Mutually locate and agree on pulling sites and splice points at the same time tower sites are staked.

6) Use self-propelled spacing buggies (wire trollies used to install spacers on conductors).

11.4.1.6. Final Clean Up and Restoration

1) Conduct a thorough and complete clean up.

2) Restore all soils and vegetation to as near the original condition as possible.

3) Have qualified subcontractors reseed and revegetate, doing so at the proper time of year and with adaptable native species.

4) Order sufficient seeds and fertilizer very early. Specify in the contract the percent purity germination and inert material.

5) Plan excess earth material disposal mutually and early.

6) Install erosion bars wherever needed.

7) Repair fences and gates and repair and clean cattle guards.

8) Close, seed, and otherwise restore all temporary roads.

9) Complete slash disposal as needed.

10) Bring all permanent roads up to proper standards for future maintenance.

11.4.2. Maintenance

1) Allow no herbicides or insecticides.

2) Perform vegetative management to minimum safety and operation standards with minimal impact equipment and procedures, such as small machines and hand held devices.

3) Promote planting of low growth native vegetation. Grasses and shrubs introduced should be compatible with existing plant communities and usable by wildlife and/or livestock.

4) Minimize maintenance roads and helicopter landing sites.

5) Inspect for environmental damage or inadequate restoration and correct defects.

6) On agricultural lands, maintenance should be performed in a manner to reduce crop or pasture damage.

11.4.3. General

1) Obtain a complete list of equipment types, crew sizes, and planned construction sequences.

2) Comply with all local, state, and federal environmental and sanitary requirements.

3) Comply with U.S. Forest Service and BPA construction guidelines throughout the line length. Use these as a model for state and private lands.

4) Require a complete maintenance plan and agree on procedure allowable.

5) Make utility responsible for correcting all latent defects to roads, fences, gates, crops, excavation, restoration, and other construction or maintenance activities for a period beyond the end of construction for at least five years and preferably for the entire lifetime of line.

6) Brief all contractor supervisors and employees on environmental constraints prior to and during construction orally and written, formally and informally. Post such reminders on job sites.

7) Have sufficient technically qualified engineering inspectors on the ground from the beginning with authority to enforce compliance if necessary to protect the environment.

8) Explain that unwarranted damage, particularly in earthmoving, will be cause for contract extension and additional cost as the line must be constructed with minimal environmental degradation.

9) Government officials of cities and counties along the transmission line route should be given advance notice of the phases of construction, the crew size anticipated for each phase at that locale, the period and length of time that the crews will be in the vicinity, and an estimate of the number of school children accompanying the crews.

FOOTNOTES
CHAPTER ELEVEN

1. Montana Power Company has recently indicated that construction crews will probably not reach the figure of 300 construction personnel since there appears to be a shortage of skilled manpower. (John W. Ross, attorney, Montana Power Company, Sept. 9, 1974.)

2. Six months construction time should be considered a minimum period of time. Recently MPC has indicated a construction schedule of 15 to 18 months for each line segment from Colstrip to Broadview. (Critical Path Diagram - Construction of Colstrip to Broadview 230 KV Double Circuit Line, Montana Power Company. Drawing No. 1635-6, April 30, 1974.)

CHAPTER TWELVE Long-Term Impact Considerations

Alternatives to the proposed facilities are discussed in various chapters of this report. Therefore, further discussion of alternatives will not be presented here.

12.1. Adverse Impacts Which Cannot Be Avoided

12.1.1. Power Plant

Large power plants, such as those proposed to be built at Colstrip create a large number of impacts upon the natural and cultural environments, many of which are adverse. Chapters 7 and 8 treat those impacts which are expected to occur if Colstrip Units 3 and 4 are built as proposed. By careful design and use of adequate controls some of the impacts described earlier in this report could be eliminated, but others are inherent to the plant complex and cannot be avoided. This section treats those adverse impacts which cannot be avoided if the plant is built.

12.1.1.1. Aesthetic Impacts

Aesthetic values are highly personal and involve one's feeling of beauty-visual and otherwise. Although these values cannot be quantified, they are an important, driving force in human affairs and one of the aspects that make man human. To deny aesthetic values in our environment deprives us of some of that humaness (Dubos 1968).

In the minds of many people, no power plant can be visually attractive. Despite clever photographs and paintings, colorful paint on the exterior, landscaping, and the like, many persons will view the power plants at Colstrip as ugly, obtrusive symbols of man's arrogance in a land of broad skies and pretty hills. Others will not share this view, and for them there may not be any aesthetic impact. Other persons will consider other kinds of aesthetics.

Less than 100 years ago, the Colstrip area was inhabited by the American Indian living a life free from any domination. Shortly thereafter the Indian was pushed aside and the white cattlemen came to dominate the land. Less than 98 years after General Custer passed within a few miles of Colstrip, huge machines were tearing up the land, a tall stack with flashing lights dominated the sky, and plans were being made to bring more changes to the land than had occurred in millenia.

These concerns are sometimes thought to be "emotional" influences which should be ignored, although emotions are considered wrong only when they get in the way of "progress." Emotions in other places and times wrought the great cathedrals of Europe, established a free nation on this continent, and clashed at the Little Bighorn 98 years ago. The aesthetic impacts must not be overlooked.

12.1.1.2. Land Use Impacts

Land use would be affected in several ways by the proposed plant and associated facilities, which would occupy about 700 acres. Although perhaps this area could be reduced in size, a large area would still be affected. The mining of coal for the plants would disturb much more land and restrict its use. At 150 acres per year, the mine would disturb some 5,500 acres in 37 years, and this amount would increase if the plant operates longer. Even if complete reclamation is possible, several hundred acres would be out of production at any one time. The additional land use requirements for living space and recreation of plant and mine employees and their families would have an impact which cannot be avoided.

The commitment of land to industrial purpose establishes new patterns around which future land use will evolve. The location of future industrial, residential, and commercial centers will fall under the influence of these new patterns. Effective land-use planning could eliminate some of the undesirable patterns, but the influence of Units 3 and 4 would be unavoidable.

12.1.1.3. Pollution

Pollution is an unavoidable impact of any power plant. Abatement devices, no matter how sophisticated, cannot control all of the pollutants, and as collection efficiency rises so do costs of both plant operation and energy consumption. Meadows et al. (1972) illustrate this fact by showing costs of reducing SO_2 and particulate pollution in a city. A 5% reduction in SO_2 and 22% reduction in particulates would cost $50,000. A 42% and 66% reduction, respectively, would cost $7.5 million, and a 48% and 69% reduction would cost $26 million.

Some particulates, SO_2, NO_x, and trace elements are unavoidably emitted into the air. Meeting air pollution standards is not the same as zero impact. For some pollutants, no standards exist because not enough study has been done to determine what concentrations would be tolerated in light of the practicality of abatement. Other standards are based upon extensive studies and are a compromise between impacts and cost of control. In an area such as eastern Montana where the pollutant concentrations in the air are much lower than permitted by the ambient air standards, the power plant could meet all pollution standards yet seriously degrade existing air quality.

Carbon dioxide, a gas given off by burning organic substances such as coal (or food in our bodies) is not considered a pollutant. Yet continued, large-scale burning of fossil fuel is increasing the amount of this gas in the atmosphere (Williamson 1973). Increasing carbon dioxide concentrations could bring on a warming trend in the climate. However, because of the complexity of the meteorologic systems involved, the effects of increased carbon dioxide levels are unknown.

Water pollution due to the ash disposal ponds, mining, and the domestic wastes of increased population may also be unavoidable. However, proper design of all types of facilities could keep water pollution from some of these potential sources minimal.

12.1.1.4. Use of Natural Resources

The proposed power plant would directly and indirectly consume large amounts of natural resources, many non-renewable. Use of these resources is unavoidable. Section 12.2. treats this topic in more detail.

12.1.1.5. Social and Economic Impacts Upon Existing Communities

The proposed Colstrip project is an increment in the industrialization of a predominantly agriculturally based region. The social and economic impacts of this process are enormous. Although it is sometimes a matter of personal preference and values to decide which impacts are adverse, major changes in local communities, both good and bad, are unavoidable. Populations will fluctuate; more services will be required; persons having different lifestyles and values will move into the area, and changes in the number, types, and ownership of business will certainly take place. Whether the community structure eventually consists of an agricultural-industrial mixture, or is entirely dominated by coal-based industry, the present lifestyles will be lost forever.

12.1.2. Transmission Line

The impacts of transmission lines are diverse and varied, as shown in Chapter 11; however, many of these impacts can be avoided by changes in line design, even though the design may be made more expensive. This section will briefly summarize those impacts which cannot be reasonably avoided if the lines are constructed.

12.1.2.1. Aesthetic Impacts

Unless the line is placed underground, which is not a reasonable alternative at this time, the towers and conductors will be aesthetically unpleasing to many persons. Aesthetic impacts include, but are not limited to, visual impacts. The presence of a man-made object in an otherwise wild part of the state offends many people. Large transmission lines are symbols of different things to different people. Some view the thin strands of metal as a web connecting the lives of distant persons, while others may view the lines as symbols of man's "progress" in "conquering nature"--a symbol perhaps more widely accepted in earlier times.

Most persons live, work, and travel near distribution lines, highways, railroads, and other man-made features. The aesthetic impact of a transmission line along a highway is quite different from one over a pristine mountain. One school of thought is that lines should be built along areas such as highway corridors already strongly affected by man. The lines would therefore not affect more natural areas. An opposing school of thought examines the number of persons who must view the lines and would prefer to have them hidden. If the lines are built, no matter which school of thought is followed, some people would be offended. Where a line can be built along existing corridors but out of sight of residents and travelers (and many parts of Montana allow this compromise), the least impacts may result.

Careful tower design and the use of nonspecular coatings on towers and conductors reduce aesthetic impacts, but there is no consensus on what constitutes a "pretty" tower.

12.1.2.2. Land Use Impacts

The presence of a transmission line affects land use. Certain activities are restricted in the right-of-way, and agricultural and timber production is reduced.

The proposed lines would be some 430 miles long and require a 300-foot right-of-way, committing a total of 15,636 acres. Although this land would not become useless wasteland, certain potential activities and some production would be lost. The spatial limits of environmental impacts are not those of the right-of-way; some impacts, such as the area taken out of production by the towers, are limited to a small part of the right-of-way, whereas others, such as those caused by some form of pollution, extend well beyond the boundaries of the right-of-way. As a lineal feature of the landscape, the lines could serve as a partition to some activities, therefore subtly affecting a much larger area. The support towers interfere with farm machinery, and tall equipment such as drilling rigs could not be used under the lines. It is best that houses and other such structures not be built in the right-of-way. In forested areas, tall trees would be removed and kept from growing back, although shorter trees may be allowed and some economic benefits may be realized.

Such electrical effects as induced ground current and radio interference are unavoidable in themselves and further act to restrict activities near the line.

12.1.2.3. Use of Natural Resources

Building the transmission line would require the use of a number of natural resources. The manufacture of the towers and conductors requires additional resources and creates pollution. This subject will be treated in Section 12.2.

12.2. Irreversible and Irretrievable Commitment of Resources

Construction of the proposed Colstrip project would directly and indirectly commit vast quantities of resources. Except for some material that may be salvaged and recycled into other uses (such as the copper and some of the steel), most of the resources are irreversibly committed. The materials that actually make up parts of the plant constitute only a portion of the total commitment.

12.2.1. Energy

Although the proposed project is an energy converter, energy is used in building and operating the plant. Since data are unavailable to quantify energy expenses, the topic will be treated qualitatively.

Of the total energy expended in the creation of Units 3 and 4, most will be consumed in mining, processing, and manufacturing the materials that will physically make up the plant. The thousands of tons of steel, wire, pipe, concrete and other materials must be transported to the site and assembled. Transportation consumes energy, the amount depending upon the type of conveyance and distance covered. On site, energy is used to handle and assemble the various materials.

The total energy consumed is expended in many complex systems. The manufacture of Portland cement used to make the concrete structures is one of the simpler examples. Clay, limestone, and other materials are mined by power equipment using electricity and petroleum products. The raw materials are then transported to the cement plant which requires energy. In the plant, the materials are handled repeatedly in the crushing, grinding, and blending prior to firing in a kiln. The kiln uses large amounts of energy derived from coal, oil, or gas to raise the temperature of the raw materials to about 2600° to 3000°F.

The product is further handled and finally shipped to the buyer. Additional energy is used in pollution control at the cement plant. The building and maintenance of the equipment in the mines and plant further add to the energy commitment of the finished Portland cement. Similar but more complex systems provide the copper, stainless steel, and other materials that go into the power plant. Construction of the Colstrip project would result from great expenditures of energy in other portions of the industrial sector of our society.

Once built, the plant would continue to depend upon energy to operate; much being derived from the plant itself. Coal mining uses electric and diesel powered equipment. At present rates, the energy to mine the coal costs 10.2¢ per ton which breaks down to 3.4¢ for electricity and 6.8¢ (.23 gallons) for fuel oil. The figure does not reflect energy costs of building the mining equipment. Auxillary power requirements of the plant are about 78 megawatts per unit or about 11% of the total output. Most auxillary power is needed to operate the pollution control equipment. A question arises as to how much net energy the Colstrip project would produce in light of the requirement of more such plants in the future. Although the Colstrip project cannot replace the energy used to build it, the project would contribute to the building of future power plants if electrical generation capacity continues to grow. The building and operation of future power plants will generally rely upon lower grade mineral deposits (including fuels), many located in remote parts of the earth. The increased transportation costs and more sophisticated technology needed to utilize these deposits, and to control pollution in the conversion and manufacturing of the materials used in future power plants will increase the total energy costs of each new plant.

12.2.2. Non-Renewable Resources

The non-renewable resource costs of the Colstrip project are as complex as the energy costs. The plant itself would use some 45,000 tons of steel, 94,000 cubic yards of concrete, over 1100 miles of wire and cable, and over 100 miles of pipe plus much more material in various components. Some six million tons of coal would be needed each year to operate the plants if they are constructed. The transmission lines would require about 40,000 tons of steel for the towers, 34,000 tons of steel and aluminum for the conductors, and 600,000 insulators plus an undetermined amount of concrete and other materials. Still other materials are used in manufacturing and processing the materials that actually go into building the plant and transmission lines. Metallurgical grade coal and limestone are used in steel production. Steel is used to produce some copper. Coal, oil, and natural gas are used to provide energy in the manufacturing processes. Oil is also used to produce a variety of necessary materials including plastics. Metals and energy from fossil fuels become mining equipment that provide the metallurgical coal for steel production that goes into the Colstrip plant and transmission lines, and so on. The exact amount of non-renewable resources needed to build the Colstrip project is impossible to figure, because, when considered in total, the Colstrip project becomes an indistinguishable part of the entire industrialized system.

The use of non-renewable resources is of consequence in that as the finite supply is consumed, future use will depend upon poorer, less accessible deposits and/or reliance upon more sophisticated technology for resource recovery.

12.2.3. Timber and Agricultural Products Lost

Timber and agricultural products are renewable and land use changes, in many cases, are reversible; however, products not grown are lost and cannot be replaced. A field of wheat not harvested because of construction activity is an irreversible loss of that field's production for that year.

Loss of biological production would result from long-term land use changes at the plant site, at the mine, and along the transmission line, and short-term land use changes would result during construction of transmission lines and pipelines, and coal mining (if reclamation is successful). Pollution and electrical effects could reduce biological production in the vicinity of the plant and transmission lines.

12.3. Long-Term Considerations of the Proposed Colstrip Project

Both individually and collectively, people tend to view the world on a short-term basis. Consideration of long-term effects of their actions plays a small role in decision-making. Similarly, people place more emphasis on local situations than upon national or global ones. Thus long-term, global implications of a particular action have the least weight in decision making (Meadows et al. 1972).

A large power complex, such as the one proposed for Colstrip, has both long-term and national (and global) implications. Since these wider-ranging effects are different from the local, short-term connotations, some attempt must be made to evaluate the proposal to build the facilities in light of the long-term effects.

In recent decades, man has experienced rapid growth of scientific knowledge and technological innovation. The great expansion of knowledge in these areas has strongly influenced the evolution of twentieth century civilization. Although not all of this change has been detrimental to mankind, neither has it been totally beneficial. All too often, major social, political, and economic changes have accidently (not planned) come about as a result of technological change. Mankind follows the paths of latest inventions with little thought as to where all these paths will eventually lead. Technological feasibility has become the determining factor in decision making. What can be done takes precedence over what should be done (Dubos 1970).

This type of thinking, which might be called the progress ethic, was exemplified by Eric Walker in a newspaper article during the debate over funding an American supersonic transport (1971). His thesis was that the U.S. will someday have an SST because: 1) it is technically possible, 2) the Russians already have one, and 3) "just ridiculous" environmental concerns would be overcome by the engineers. He completely ignored the basic question of whether an SST is desirable and should be developed.

12.3.1. Montana Considerations

Unlike land which can produce crops and provide a living for many generations, a power plant has a rather short life. Likewise, the coal deposit, once mined, is depleted forever. The tax base and jobs provided by the Colstrip project would be transient. Continued taxes and jobs past the life of the plant would be dependent upon other industry situated in the area and agriculture.

Persons who would fill the newly created jobs are not necessarily those living in Montana at present. Unemployment in other parts of the nation besides a desire to live in Montana (because of its uniqueness) could cause great numbers of people to immigrate to the state. Children of the immigrants of coal development may well out-number the jobs available in 30 to 50 years. Unemployment may be much higher than at present as the power plants are phased out resulting in large numbers of persons (who would now be long-time residents) being forced to leave the state.

An alternative to this scenario would necessitate continued industrial development in eastern Montana. Continued long-term industrialization to maintain employment and a tax base has even more profound effects which cannot be evaluated at this time. Pittsburgh, Pennsylvania, a heavily industrialized urban area, obtained much of its character from the rich coal deposits in the area. Although Rosebud County will probably never duplicate Pittsburgh, the two areas may share some characteristics if large scale coal development proceeds.

Although long-term effects of the Colstrip project are difficult to evaluate, we must not allow the possibilities of technology and the promise of short-term benefits to lead us unwittingly in directions that may prove to be detrimental. The implications of such decisions must be well analyzed, and the choice we make for the future of our state must be with full realizations of the consequences.

12.3.2. National and Global Considerations

Much of the world has become industrialized in the past one and a half centruies. Factories and large industrial communities have sprung up in many countries. Mechanized agriculture which requires fewer persons to feed the society and the need for more manpower in the industrial sector have caused large population shifts from rural to urban environments. With industrialization came shorter workweeks and a greater supply and variety of consumer goods and services. Better medical care and abundant food allowed the population to grow to increasingly higher levels. In providing material goods, security, and comfort, industrialization has worked very well in the United States. Based upon consumption of resources, the United States is outstanding. With only 6% of the world's population, we consume about one-third of the world production of raw materials and energy (Singer 1970).

Industrialization, in the context used above, is a complex process involving all aspects of society. Social, economic, political, and technological systems have changed or grown in the process. Especially in the twentieth century, technology and highly technological systems, which have accounted for much of industrialization's success, have grown enormously.

The lifestyle enjoyed by the majority of Americans in the 1970's is one of relative security, comfort, leisure, and an abundance of material commodities. It is also totally dependent for its existence upon a large number of highly complex systems. Combined in a mutually interdependent manner, these complex systems form a higher order system (supersystem) that not only provides our amenities but keeps us alive by providing our basic needs. Very few people grow their food, make their clothes, build their homes, or collect the fuel to heat those homes. Even today's farmer generally buys much of his food at a supermarket.

The supersystem feeds and grows upon itself with the help of several contributing factors: 1) increasing population, 2) growth of per capita consumption, 3) increasingly complex systems to produce the raw materials and products to sustain high populations and per capita consumption, and 4) increasingly complex systems to remedy the ill effects of the producing systems. These four factors will be analyzed separately.

The population of the world is rapidly growing. The approximately 3000 million world population in 1970 may double by year 2000 (Meadows et al. 1972). Even in the United States where birth rates have fallen to levels that, if continued, would result in zero population growth, the population will continue to grow for several decades before leveling off. Based on estimates using the lower fertility rate (U.S. Department of Commerce 1973), the United States population will grow from 204 million in 1970 to 264 million by 2000 and 297 million by 2020.

Additional persons require more food, more housing, and more services. To double world food production would require basic changes in agriculture with resultant social and economic changes (MIT 1970). But supposing these changes could be made and such innovations as the high yield strains of grain would produce as originally expected, the increased supply of food would be inadequate within several decades if the world population continues to grow at the present rate. Increased agricultural production has been accomplished by mechanization and the increased use of energy and chemicals. This trend makes the agricultural producer more dependent upon the systems which provide his machinery, fuel, fertilizer, and other commodities. More people put more stress on the systems which provide housing, transportation, medical services, and so forth. These systems ultimately demand more energy, minerals to build additional schools, hospitals, transportation systems, and the like. As long as resources remain abundant, a growing economy can accommodate the population growth but as resources become scarce shortages and inflation occur.

An increase in per capita consumption places demands upon the producing systems just as increasing population does. Most people aspire to have more goods, services, and comfort regardless of what they already have. This aspiration makes itself felt in union halls and voting booths, resulting in business and governmental response which adds further to the growth of the supersystem.

Raw materials, especially non-renewable resources, are limited in amount. As the easy-to-get materials are consumed, more sophisticated techniques are required to obtain more. Agricultural products, timber, and mineral resources all share this characteristic. To produce more corn, more marginal land must be farmed using special hybrid seed, more fertilizer, insect and weed killing chemicals, and energy in planting, harvesting, and transportation. To produce more oil, remote and marginal fields must be brought into production. These fields require deeper drilling, off shore drilling, or extensive transportation problems. The oil resources such as those found by observing seeps and recovered by the primitive devices available to Colonel Drake in 1859, are mostly depleted. Instead, oil is found and obtained at sea and in the Arctic by incredibly expensive techniques, using sophisticated technology, and many men and materials.

Large-scale production brings many kinds of environmental degradation, including pollution. Many industrial processes produce waste or allow materials to escape into the environment as pollutants. Processes which consume electricity, but are otherwise pollution free, merely transfer the emission of pollutants from the factory to the power plant. Since the atmosphere, land and water of this planet are finite, pollutant levels tend to rise with greater production. To avoid severe environmental damage, technology has been applied to control pollution. In some cases, where a usable product is the pollutant, an economic saving can be realized from control; in most cases, pollution control is expensive. Sophisticated equipment and additional energy requirements increase the costs of production. Without pollution control, the costs are in the form of damage to human health and natural resources. Pollution control adds to the complexity of the producing systems and increases consumption of resources.

Many persons in our society believe that all problems can be solved by technology, and, consequently, that population and economy can grow without limit by continued application of new technology to solve the problems that arise. A glance at history serves this point of view well. For example, if we had to depend on wood for our fuel as our ancestors did, we would have frozen to death many years ago. Large power plants, ocean-going supertankers, and nuclear reactors could not be foreseen in 1840. However, technological innovations do not always work as planned, as problems with the "miracle" strains of grain, DDT, Egypt's Aswan Dam, and some modern rapid transit systems attest.

More advanced technology in a given area usually depends upon other systems which in turn require more technology. As the supersystem becomes more complex, economic and social perturbations become greater threats to the whole and each technological breakthrough becomes more essential. As the sophisticated and complex society becomes more dependent upon all of its systems, the risks involved in an incorrect political decision, economic depression, social upheaval, or war become enormous. Since personal survival is dependent on the supersystem for basic needs as well as maintenance of the life-style, a strong perturbation could initiate additional social, political, and military disruption which might hasten the collapse of the society. In this case, prolonged dependence upon advanced technology, if it adds to the fragility of the system, would be detrimental. The disaster initiated by the drought in the Sahel demonstrates that the reality of this kind of catastrophe is not a piece of science fiction (Wade 1974). Although the Sahelian problem was geographically isolated, a similar collapse could occur in the more advanced countries: made more likely by the strong interdependence of many countries and the threat of global nuclear war.

V.E. McKelvey illustrates part of the problem (1973):

> ...in attaining our high level of living in the United States, we have used more minerals and mineral fuels during the last 30

> years than all the people of the world used previously. This enormous consumption will have to be doubled just to meet the needs of the people now living in the United States through the remainder of our lifetimes, to say nothing about the needs of succeeding generations, or the increased consumption that will take place in the lesser developed countries if they are to attain a similar level of living.

And further,

> If resource adequacy cannot be assured into the far-distant future, a major re-orientation of our philosophy, goals, and way of life will be necessary. And if we do need to revert to a low resource consuming economy, we will have to begin the process as quickly as possible in order to avoid chaos and catastrophe.

If we include under "resource adequacy" the social, economic, and technological systems which convert raw resources into usable products and services, continued growth without regard for long-term dangers becomes a gamble. The Colstrip project would add to the growth of the size and complexity of the supersystem which some (Meadows et al. 1972) feel will ultimately fall. If the prediction is true, all social, economic, and environmental impacts, except as they contribute to the demise of the system, become minuscule.

12.4. Public Involvement

12.4.1. Background

By January of 1974 substantial public comment had been generated on Colstrip-related proposals. The final EIS on Units 1 and 2 (now under construction), published by HES reported over 3,000 written responses from the public relating to the proposal. These responses came in the form of letters, postcards, coupons and signatures on petitions, and approximately 95% of the responses opposed development of the plant and coal mining operations (HES 1973).

The final EIS reported that the fears most often expressed were:

1) Strip mining would proceed with little, if any, adequate reclamation of the land.

2) Air and water would be polluted significantly.

3) Large-scale water consumption would result.

4) Montana would emulate the bad characteristics of other states.

5) Present life-styles would be disrupted.

However, the EIS also reported that two major misconceptions were expressed or implied by most of the respondents. First, many people appeared to believe that all of the power from the Colstrip plant would be used outside Montana. Second, most of the responses were written "seemingly with the belief that the Air Quality Bureau (of HES) could decide to issue or deny a permit on the basis of popular opinion or criteria other than the standards established in the regulations" (HES 1973).

In the current climate of public concern, public comment of an even greater magnitude can be expected on the Colstrip Units 3 and 4 proposal. In order to process, evaluate and utilize public comment of this magnitude, as well as to dispel misconceptions that would render the comment invalid, the Department funded and staffed a public involvement program in June, 1974.

12.4.2. The Need for and Purpose of Public Involvement

Abraham Lincoln once said: "In this and like communities, public sentiment is everything. With public sentiment nothing can fail; without it nothing can succeed." In an area of increased public awareness, education, and communication, members of the public have come to demand an increased voice in executive political decisions. Samuel Jackson said, "The '70s will be a decade in which all segments of our society will demand an effective voice in shaping the policies that affect their lives. Citizens will be impatient with a philosophy that tells them "father knows best" and they will demand a more active and meaningful participation in the planning process" (Jackson 1970).

An increased public voice in executive decisions will not only meet the public demand, it will also enable the agency to render better managerial decisions. If decisions are made in order to meet the values needs and concerns of people, then public involvement can provide a means for the agency of detecting those values, needs and concerns.

Edward Cliff wrote, "A greater degree of constructive public involvement will enable us to do our job better and with greater sensitivity and responsiveness than has been possible for us to achieve in the past" (USDA 1971).

Public involvement in the planning process can provide functional communication between the planner and the public so as to most efficiently transmit pertinent information which will elicit feedback from the public on perceptions of needs and preferences (U.S. Army Corps of Engineers 1970).

Public involvement, then, can educate and inform the public on the facts surrounding the problem. More importantly, public involvement can identify public concerns. Armed with this knowledge, the decision makers can then blend public concerns into the given physical, fiscal, political and legal restraints and develop the best possible solution.

12.4.3. Special Need for Public Comment on Transmission Lines Study

In the event that Colstrip Units 3 and 4 are approved, it seems clear that the transmission lines would be constructed. A decision to deny construction of the transmission lines would be a de facto decision to deny construction of the power plants. However, in the event that the generating units are approved, there is a need for public comment on the construction of the transmission lines.

Although there are a number of variables such as construction practices, the two most significant would be line design and corridor selection. The Department intends to take local values and concerns into account when generating an optimum corridor, for science can only predict the impacts transmission line characteristics would have on separate environmental elements (see Section 11.3. "Impacts of Alternate Corridors"). To determine whether the impacts are acceptable requires comment from the public.

Trade-off situations often arise in corridor selection, in which one environmental value must be placed above another. For example, it may become necessary to evaluate visual impact along a highway against the impact of locating transmission lines in a roadless area. Many of these trade-off situations may be encountered, and they all require public comment if proper decisions are to be made.

Finally, public comment helps the division identify local concerns of which it may have been unaware. Examples of these are local private airfields, waterfowl habitat, and isolated scenic areas of local values, a local historical site, etc.

12.4.4. Public Comment on the Draft EIS

A public comment period will be extended for at least 45 days following publication of this impact statement. Public comment will be solicited and accepted under a variety of methods, including verbal and written comment at public meetings, telephone calls, letters, postcards, petitions, etc.

A series of eighteen public meetings will be conducted in selected communities throughout the study area from November 25, 1974 to January 9, 1975. The communities will be, in chronological order: Plains, Ovando, Anaconda, Butte, Helena, Great Falls, Bozeman, Big Timber, Harlowton, Townsend, Custer, Hardin, Forsyth, Miles City, Billings, Polson, St. Ignatius and Missoula.

The exact times and locations of each meeting will be announced by the statewide media. A complete meeting schedule can be obtained by writing to the Department. In addition, meetings with special groups are possible by special arrangement.

All public comment received by the Department will be carefully analyzed, tabulated, and recorded. The results of all public comment will be included in the final EIS, and will be reported to the Board of Natural Resources and Conservation for its consideration in making a final decision on the application.

GLOSSARY

AMBIENT AIR
Surrounding air.

APPROACH
The difference between the temperature of cooling water leaving the cooling tower and the wet bulb ambient air temperature.

ASSOCIATION
In Clement's sense, a climatic climax unit that includes all of the successional stages preceding or associated with it. Plant association and animal association emphasize populations of plants and animals, respectively, within an area.

BAFFLES
Used to direct the flow of combustion gases and ensure maximum contact with the heating surface.

BIOMASS
Living weight; the total quantity per unit of space at a given time of living organisms of one or more species (species biomass) or of all the species in a community (community biomass). Cf. yield, productivity, standing crop.

BLOWDOWN
The act of draining or flushing out boiler or other water which has become too concentrated with solids or other contaminants.

CAPACITIVE LOSS
The loss of power, mainly in the form of heat, due to capacitive reactance.

CAPACITIVE REACTANCE (X_C)
The characteristic of capacitors of opposing the flow of alternating current. Measured in ohms.

CAPACITORS (C)

Two conducting materials separated by insulating material, with the capability of storing electrical energy for a period of time.

CIRCUIT BREAKER

A device used to close or open an electrical circuit.

CLIMAX

A community capable of self-perpetuation under the prevailing climatic and edaphic conditions; the terminal stage of a sere under the prevailing conditions.

COMMERCIAL FOREST LAND

Forest land which is (a) producing, or physically capable of producing, usable crops of wood (usually sawtimber), (b) economically available now or prospectively. and (c) not withdrawn from timber utilization.

CONDENSERS

Same as capacitors

CONVERTERS

The set of electrical equipment which can convert A.C. electricity into D.C. and vice versa. The set includes rectifiers and inverters.

CURRENT

A movement of electrons due to EMF between two points (e.g. two ends of a wire) when a conducting path is provided. These electrons are part of the atoms which compose the conductor or any other matter. Measured in amperes.

DBH

Diameter breast height. On standing trees, a standard height from ground level for recording diameter, girth, or basal area. In the United States, this standard height is 4 ft. 6 in. (1.37m).

DECIBEL (db)

A unit for measuring the relative strength of a signal parameter such as power, voltage, etc. The number of decibels is ten times logarithm

DECIBEL (db) Cont.

(base 10) of the ratio of the measured quantity to the reference level. The reference level, such as 1 milliwatt for power ratio and µv/m or mv/m for voltage, must always be indicated.

DIFFUSION

Process by which gas, liquid, or solid particles are transported from a region of high concentration to a region of low concentration. On a molecular level, diffusion is due to thermal agitation. Diffusion in the atmosphere is due primarily to wind fluctuations.

DIP

Angle of inclination of tilted geologic strata.

ECOSYSTEM

A community including all of its component organisms, together with the abiotic environment, forming an interacting system.

ELECTROMAGNETIC FIELD

The region around a conductor carrying A.C. current, which can exert a force on magnetic material or material carrying A.C. current if placed in proximity.

EMF (ELECTROMAGNETIC FORCE)

The force or pressure, measured in volts, which makes or tends to make electrons move.

EUTROPHICATION

The normally slow aging process by which a lake evolves into a bog or marsh and ultimately assumes a completely terrestrial state and disappears. During eutrophication the lake becomes so rich in nutritive components, especially nitrogen and phosphorus, that algae and other microscopic plant life become superabundant, thereby "choking" the lake, and causing it eventually to dry up. Eutrophication may be accelerated by many human activities.

FAULT

A fracture or zone of fractures in the earth along which movement has occurred.

FOREST LAND

Land which (a) is stocked on at least 10 percent of its surface by trees of any size, and capable of producing timber or other wood products, or of exerting an influence on the climate or on the water regime; or (b) has had the trees described in (a) removed to less than 10 percent stocking, and which has not been developed for other uses.

FORMATION

A body of rock strata that have properties distinguishing them from other strata and that can be recognized as a unit.

GRASSLAND

Any land on which grasses dominate. Also, land originally dominated by grasses.

GROUP

Two or more geologic formations considered as a unit.

HABITAT TYPE

Collective term for those areas that support or can support the plant association, or did support it prior to its destruction or modification by fire, flood, grazing, logging. It is the physical environment of a particular association.

HEAVY METALS

Metallic elements with high molecular weights, generally toxic in low concentrations to plant and animal life. Such metals are often residual in the environment and exhibit biological accumulation. Examples are mercury, chromium, cadmium, arsenic, and lead.

HORIZONS

The individual horizontal layers of soil that appear when a downward section is cut through the soil. For convenience in study and description, the layers or horizons resulting from the soil-forming processes are grouped under four headings: O, A, B, C. The O horizons are organic materials which form above the mineral soil. The A horizons are composed of mineral soils which lie at or near the surface and are characterized by a zone of maximum leaching. The B horizon is the region of

HORIZONS - Cont.

maximum accumulation of materials such as iron and aluminum oxides and silicate clays. These materials have been washed downward from the surface horizons. The C horizon is the zone of least weathering and is the accumulation zone of calcium carbonates and magnesium carbonates. Cementation occurs frequently.

IMPEDANCE

The total opposition of a conductor to the passage of an electric current through it, caused by the combined effects of the characteristics of the circuit resistance, inductance and capacitance.

INDUCTANCE (L)

The property of a circuit (or conductor) that causes a voltage to be induced in the circuit (or conductor) by a change of current. Measured in henries.

INDUCTIVE LOSS

The loss of power, mainly in the form of heat, due to inductive reactance.

INDUCTIVE REACTANCE (X_L)

The characteristic of inductors of opposing the flow of alternating current. Measured in ohms.

INVADER

Plant species that are absent in undisturbed portions of the original vegetation, and will invade under disturbance or confined overuse.

INVERTER

The electrical device used to convert direct current into alternating current.

ISOTHERMAL LAYER

Layer in the atmosphere in which temperature does not change with altitude.

LATENT HEAT

The heat given off or absorbed at constant temperature when a substance changes phase (i.e. melts, freezes, evaporates, condenses, etc.).

LIQUOR

The liquor present in the scrubbers is a combination of the particles of combustion, water, and whatever chemicals are present. Some of these elements may be dissolved in solution and some may just be suspended.

LOAD FACTOR

The ratio of the actual output for a given unit in a certain length of time to the nameplate or possible output in the same length of time.

MEMBER

A subdivision of a geologic formation.

MERCHANTABLE

(Said of trees, crops, or stands) of a size, quality, and condition suitable for marketing under given economic conditions, even if so situated as not to be immediately accessible for logging.

NITROGEN DIOXIDE (NO_2)

Produced from the combustion of coal, fuel oil, natural gas and gasoline used in power generating operations. NO_2 can cause direct damage to vegetation.

NONCOMMERCIAL FOREST

Forest land stocked by species that have no value commercially.

NOXIOUS PLANTS

Undesirable plant species that are unwholesome to the range or animal. Not to be confused with species declared noxious by certain laws.

NUCLEI

Particles (dust, sea salt, etc.) in the atmosphere which promote the formation of liquid water droplets from water vapor (condensation nuclei) or of ice from liquid or gaseous water (freezing nuclei). In the absense of freezing nuclei ice would not form in the atmosphere at temperatures above - 40°C.

OZONE (O_3)

An allotropic form of oxygen, containing three atoms in the molecule. It is a bluish gas, very active chemically, and a powerful oxidizing agent. It is formed when oxygen in the air is subjected to a silent electric discharge. It occurs in ordinary air in small amounts only. The photochemical reaction of hydrocarbons and nitric oxide can also produce ozone. Ozone can severely injure many forms of plant life.

PARTICULATE MATTER

Dispersed solid or liquid matter in which the individual aggregates are larger than a single molecule (U.S. Dept. HEW 1970).

PHASE

Used in A.C. terminology. When two alternating currents (or voltages) are in phase, they reach their corresponding zero, maximum, and intermediate values at exactly the same instant. If they do not they are said to be out of phase. The condition in which phase differences between electrical systems is at regular intervals and with a constant phase-angle is called polyphase. The alternating current used normally is three phase.

PHOTOSYNTHESIS

The synthesis of chemical compounds effected with the aid of radiant energy, especially light. Usually the formation of carbohydrates in the chlorophyll-containing tissues of plants exposed to light.

POISONOUS PLANTS

Plants containing or producing substances that, consumed by animals, result in sickness, death, or deviation from normal state of health.

POLE SIZE TREE

A young tree with DBH of 5-9".

PRISTINE (or near-pristine)

Used to describe areas on which there has been little or no grazing by domestic livestock, and which has been otherwise undisturbed. These areas show the kinds and amounts of vegetation that will develop naturally on a given soil and in a given climate, and provide criteria for determining the condition of the range.

RANGE CONDITION
The state and health of the range based on what it is naturally capable of producing.

RANGE CONDITION CLASS
One of a series of arbitrary categories used to classify range condition, usually expressed as excellent, good, fair, or poor.

RECTIFIER
A device used to convert alternating current into direct current. The mercury valve, one of the primary elements of a rectifier, can now be replaced by a new electronic device called a thyristor.

RELATIVE HUMIDITY
The ratio of the amount of water vapor contained in the air to the amount which the air could contain if saturated.

RELICT
Used to describe fragments of presently existing flora on areas with a historical record of no disturbance, where that plant community is assumed to be in near-virgin condition.

RESISTANCE
The opposition offered by the internal molecular structure of materials to the movement of electricity through them.

ROTOR
The generator rotor is a large conducting shaft which rotates inside the stator field to produce électricity.

SAW TIMBER SIZE
Trees having DBH of 9" or greater.

SEICHE
Oscillation of a body of water with a period of several minutes to an hour or more.

SEISMIC
Pertaining to earthquakes.

SERIES COMPENSATION

The use of capacitors in series to reduce the electrical length of a transmission line.

SITE CLASS

A measure of the relative production capacity of a site for the crop or stand under study, based e.g. on volume or height or the maximum mean annual increment that is attained or attainable at a given age.

SITE INDEX

A particular measure of site class, based on the height of the dominant trees in a stand at an arbitrarily chosen age (see site class).

STATOR

The generator stator is the stationary outer winding which provides the strong magnetic field necessary to produce electricity.

STOCKING

A measure of the proportion of land area actually occupied by trees, expressed in percent of canopy closure.

SYNCHRONOUS OPERATION

An operation which includes two interconnected electrical systems operating at the same phase and magnitude.

TEMPERATURE INVERSION

Condition in the atmosphere in which temperature increases as altitude increases.

THIXOTROPIC

Capable of becoming fluid when shaken.

TILTH

The physical condition of the soil in its relationship to plant growth, considering such factors as percentage of coarse fragments, depth of bedrock, fertility, texture, etc. Usually rated as good, fair, or poor.

TRACE ELEMENTS

Micronutrients; elements necessary for the operation of living systems, but which are required only in minute quantities, often as components of vital enzymes.

TSUNAMI

Large sea wave, incorrectly called "tidal wave."

UNCONFORMITY

A surface in the earth's crust representing erosion or non-deposition.

VOLATILIZATION

The process of exposing a solid such as coal to high temperatures, eventually resulting in the production of various gases.

WET BULB TEMPERATURE

The temperatures to which air may be cooled by evaporating water into it at constant pressure until it is saturated.

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